ESSAYS IN MIGRATION AND TAXATION

A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Hautahi Kingi

January 2017

ESSAYS IN MIGRATION AND TAXATION

Hautahi Kingi, Ph.D.

Cornell University 2017

"We were wanderers from the beginning."

- Carl Sagan

Exploration is in our nature. Throughout human history, migration has been vital to our survival, and continues to be central to our political discussions and economic fortunes. This dissertation contributes to an understanding of the effects of migration on welfare and taxation.

In chapter 1, I examine the welfare effects of immigration on United States workers. I build a dynamic search and matching model in which immigrants and natives differ according to their outside options, separation rates, wealth holdings and skill composition. Immigration affects native-born welfare by i) altering the skill composition of the labor force, ii) lowering the expected hiring cost of firms, and iii) altering the rate of return on wealth. I demonstrate that the transition period, during which the economy adjusts to immigration, involves both higher returns to wealth and inferior labor market conditions in comparison to the long run steady state. Accounting for transition dynamics therefore shifts the welfare effects of immigration in favor of wealthy households at the expense of workers.

In chapter 2, I shift the discussion from the movement of labor across national boundaries to the internal movement of labor from rural to urban locations. I analyze the welfare effects of a policy of modern sector enlargement (MSENL), and a policy of increasing the efficiency of on-the-job search from the urban informal sector (IEOS) in a generalized Harris-Todaro model. I show that MSENL causes a

Lorenz worsening of the income distribution and IEOS causes a Lorenz improvement. In a rare direct application of the Atkinson theorem, I conclude that MSENL decreases social welfare and IEOS increases social welfare for all anonymous, increasing and Schur-concave social welfare functions.

In chapter 3, I return to international migration by investigating its effect on the ability of governments to raise tax revenue. I construct Laffer curves using a static two country neoclassical model with international labor mobility. I show that international migration i) shifts the peak of the Laffer curve to the left, and ii) is quantitatively more important than the labor supply elasticity in determining the shape and position of the Laffer curve. A simple calibration reveals that almost every country in the EU-14 is currently located on the "slippery slope" portion of both the labor tax and capital tax Laffer curves.

In chapter 4, I depart from the theme of migration while retaining the focus on the tax system. Kyle Rozema and I analyze the effect of tax expenditures on the stabilizing power of the tax system. We propose a microsimulation strategy which exploits links that we identify between automatic stabilizers, tax expenditures, and effective marginal tax rates. Using the Survey of Consumer Finances from 1988 to 2009, we estimate that, on average, the Mortgage Interest Deduction and the Charitable Contributions Deduction increased the sensitivity of consumption to income fluctuations from a baseline of 0.14 by 1.13% and 0.97%, respectively.

BIOGRAPHICAL SKETCH

Hautahi Kingi received his B.Sc. in Mathematics and Statistics, and B.C.A. with First Class Honors in Economics and Finance from Victoria University of Wellington in 2011.

To Mum, Colin and Hannah.

For your love, and your support.

ACKNOWLEDGEMENTS

In his recent book "Success and Luck", Cornell economist Robert Frank argues that personal success depends to a significant extent on chance. It is a message with which I identify very closely. I have been extremely fortunate to encounter and be supported by a number of extraordinary people.

The intelligence, inquisitiveness and intellectual rigor of my academic mentors have been both an inspiration and a source of humility throughout my time at Cornell. I am grateful to Karel Mertens and John Abowd for their generous academic guidance. I very much appreciate Karel's willingness to discuss my often wayward ideas, and the skill to steer them in the right direction. John's seemingly endless knowledge of every empirical realm of economics was as helpful as it was impressive. I thank Gary Fields for the inspiration behind chapter two, which began as a term paper for his Development Economics course. I would also like to thank Lars Vilhuber for his patience with me as his research assistant, his extremely insightful comments on my work, as well as many pleasant and wide-ranging conversations. I also appreciate the advice and encouragement provided by Viktor Tsyrennikov, Chris Huckfeldt, Assaf Razin, and Jenny Wissink. In New Zealand, Geoff Bertram and Andrew Coleman were crucial in encouraging my pursuit of a Ph.D. My work also benefited from engaging and lively conversations with many classmates, all of whom it was a pleasure to work alongside.

The opportunity to pursue independent research over the course of a doctoral career is a privilege. It is an especially rare privilege for Māori. I am thankful for the educational initiatives designed to improve outcomes for Māori – from bilingual schools to scholarships – which benefited me enormously throughout my schooling life. I am particularly grateful for the support I received from Te Roopu Awhina, whose success in furthering Māori achievement and promoting Māori academic excellence is an inspiration. While I am very aware of the many shortcomings of this dissertation, I also understand its significance as a small example of Māori achievement. May this significance continue to reduce with the ongoing success of Māori.

Doctoral studies are not cheap. I am extremely grateful for the very generous financial support provided by the William Georgetti Scholarship. The emotional burden of financial uncertainty that it lifted from my shoulders is difficult to put into words, other than to acknowledge the freedom it provided to embrace my studies to the fullest extent. I thank the Scholarship Committee for their faith in me, which I hope to continue to repay beyond Cornell. I would also like to thank Motu Economic and Public Policy Research for their financial assistance. It is a privilege and a delight to be associated with the best group of economic researchers in New Zealand.

Finally, I am forever grateful and indebted to Carol Greensmith, Colin Carruthers and Hannah Bliss. In their own unique and important ways, they have enabled me to reach this stage in my life. My gratitude for their support is only surpassed by my admiration for them as people. I dedicate this dissertation to them.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

THE DYNAMIC EFFECTS OF IMMIGRATION

1.1 Introduction

Restrictions on labor movements between countries are arguably the largest policy distortions in the international economy. Wage differentials for observably identical workers can exceed 1000% across different national markets (Clemens et al., 2008), compared to price wedges that rarely exceed 74% for goods, and 15% for financial instruments (Clemens, 2011). Estimates of the increase in world GDP caused by the removal of labor market barriers range from 66% (Iregui, 2005) to 127% (Klein and Ventura, 2007) - three orders of magnitude larger than the equivalent removal of trade or capital flow barriers.

Despite these enormous potential gains to world income, and a dramatic expansion in international migration over the last 20 years, more than 96% of humanity remain in their country of birth (International Organization for Migration, 2013). Host countries continue to restrict inward migrant entry out of public concern for the adverse effect of immigration on the welfare of native-born citizens (Mayda, 2006).[1] Understanding these welfare consequences is therefore not just important to native-born workers, but also to the substantial proportion of the world population who wish to migrate.

In this article, I examine the impact of immigration on the labor market outcomes, wealth holdings, and welfare of native-born workers in a dynamic model

[1] For example, 47% of Americans and 64% of Britons viewed migration as more of a problem than an opportunity in 2013 (Transatlantic Trends, 2013, p. 14).

with labor market search frictions (Diamond, 1982; Mortensen and Pissarides, 1994) and endogenous wealth accumulation. Migrants and natives differ according to their outside options (Chassamboulli and Palivos, 2014), separation rates (Battisti et al., 2014), skill composition (Borjas, 2003) and wealth holdings.

Within this theoretical framework, immigration affects native welfare via three primary channels - the *price* channel, the *hiring cost* channel, and the *capital surplus* channel. The *price* channel reflects standard classical factor demand theory. Immigration alters the skill composition of the labor force and the resulting factor returns which, in a competitive setting, affects wages. I demonstrate that this impact on wages is maintained in my non-Walrasian labor market setup, and that the changes in relative productivities also alter the hiring incentives of firms and therefore employment.

The *hiring cost* channel is novel to the immigration literature (Chassamboulli and Palivos, 2013). Immigrants have lower outside options than their native counterparts and are therefore willing to accept lower wages. Because firms cannot ex-ante distinguish between native and immigrant workers when posting job vacancies, immigration increases the likelihood that a given vacancy is eventually filled by an immigrant, and therefore decreases the expected wage to be paid by a firm. The resulting increase in firm surplus promotes hiring activity, which improves the labor market conditions of both immigrants and the native-born through an increase in employment and the bargaining positions of workers.

The *capital surplus* channel is related to the concept of the "immigration surplus" identified by Borjas (1995). In the absence of a perfectly elastic capital stock, immigration temporarily generates higher rates of return to capital while lowering the average marginal product of labor, thereby benefiting the owners of capital at the expense of workers.[2]

To my knowledge, this article is the first to simultaneously consider each of these three channels within the same model. Ben-Gad (2004) and Moy and Yip (2006) employ neoclassical growth frameworks with homogeneous labor to investigate the *capital surplus* channel. Ben-Gad (2008) extends Ben-Gad (2004) by incorporating skill heterogeneity to further examine the redistributive *price* channel across skill groups. More recently, Chassamboulli and Palivos (2013, 2014) and Battisti et al. (2014) examined the effects of immigration within a search and matching framework with skill heterogeneity. These studies incorporate the *price* and *hiring cost* channels but do not speak to the *capital surplus* channel.

In order to accommodate the *capital surplus* channel, I compute the full transition dynamics of the economy as it adjusts to new levels of immigration. While Ben-Gad (2008) accounts for transition dynamics in a neoclassical framework, this article is the first to do so in a setting with labor market frictions. The literature traditionally derives welfare implications by comparing pre- and post-migration steady states within static frameworks (Borjas, 1995, 1999) or by ignoring transition dynamics within dynamic frameworks (Liu, 2010; Chassamboulli and Palivos, 2013, 2014; Battisti et al., 2014). There are two issues with this approach. The first is that the transition to the new steady state can involve periods in which wages, unemployment, and returns on wealth deviate substantially from their eventual steady state values. Failing to account for these deviations potentially ignores significant fluctuations in income that could alter welfare conclusions based solely on steady state values. The second issue is that the result-

[2]Borjas (1999) estimates that this channel redistributes approximately 2% of output from workers to owners of capital within a static model, although Ben-Gad (2004) demonstrates that accounting for transition dynamics reduces this estimate by a factor of three.

ing steady state levels of asset holdings, and therefore consumption, inherently depend on the transition dynamics in an economy with heterogeneous wealth holders (Mendoza and Tesar, 1998). The literature therefore necessarily makes simplifying assumptions such as not allowing immigrants to accumulate wealth (Palivos, 2009; Liu, 2010) or forcing savings to be sent abroad (Moy and Yip, 2006). These assumptions completely eliminate the redistributive effect of the *capital surplus* channel.

The transition dynamics, and therefore the relevance of the *capital surplus* channel, crucially depend on the elasticity of the aggregate capital stock. I therefore investigate the welfare consequences of immigration under two extreme scenarios - an *open* economy in which domestic asset markets are fully open to foreign capital flows and a *closed* economy in which the aggregate capital stock is fully determined by the wealth accumulation decisions of domestic households. The dynamics of the *closed* economy are more protracted than the *open* economy dynamics because the aggregate capital stock in a *closed* economy is less reactive to the changes in factor prices caused by immigration. The marginal productivities of labor, which are increasing in the level of the capital stock, are therefore lower during the *closed* economy transition than the *open* economy transition. As a result, the *closed* economy creates inferior labor market outcomes - in the form of lower wages and higher unemployment - in comparison to the *open* economy over the adjustment period. Offsetting these negative labor market effects are the increased rates of return to capital that occur in the *closed* economy over the adjustment period. In other words, the *capital surplus* channel plays a more important role in the *closed* economy.

An additional contribution of this article is a methodological one. I adopt the preference specification of Greenwood et al. (1988) which ensures that the disutility derived from employment is independent of household wealth. This allows the coefficient on the disutility of labor to be consistent with the interpretation of an "outside option" that is common in the search and matching literature with risk neutral agents. To my knowledge, I am the first to exploit this particular implication of these preferences within a search and matching model with risk averse agents. The assumption facilitates both the steady state and transition analysis by allowing labor market dynamics, which would otherwise depend on household wealth (Krusell et al., 2010), to be computed separately from wealth dynamics.

I calibrate the model to match key features of the United States economy over the previous decade, including unemployment rates, wage premiums, wealth holdings, population shares and job finding rates for each worker type using data from the Current Population Survey and the Survey of Income and Program Participation. I simulate the effects of immigration by increasing the size of the labor force by 1% through an increase in the stock of either high skill or low skill immigrants. I do not model the migration decision itself, and instead assume that the number of migrants can be completely determined by policy - a realistic assumption for the United States.

Consistent with Chassamboulli and Palivos (2013), my baseline calibration implies that the *price* channel dominates the *hiring cost* channel in the determination of long run wages. An influx of low (high) skill migrants equal to 1% of the labor force reduces the long run wages of low (high) skill workers by 0.27% (0.91%). The same influx of low (high) skill migrants also increases the long run wages of high (low) skill workers by 0.45% (0.67%). These figures can be interpreted as long run wage elasticities and are roughly consistent with the estimates of between -0.3 and

-0.4 in frameworks with competitive labor markets (Borjas, 2003; Ben-Gad, 2008), as well as the empirical literature.

My baseline calibration also implies that steady state employment outcomes are instead driven by the *hiring cost* channel, which is again consistent with Chassamboulli and Palivos (2013). Immigration reduces unemployment for all workers, regardless of skill type. Specifically, an influx of low skill migrants equal to 1% of the labor force reduces the long run unemployment of low (high) skill workers by 0.30% (0.21%). Similarly, the same influx of high skill workers reduces the long run unemployment of low (high) skill workers by 0.29% (0.04%). These findings are also consistent with the meta analysis on the impact of immigration on employment conducted by Longhi et al. (2006), who show that there appears to be a small net job creation effect in the United States.

Low (high) skill immigration always improves the welfare of high (low) skill workers and reduces welfare for low (high) skill workers, both in the long run and after accounting for transition dynamics. The magnitude of the welfare changes, however, crucially depend on the elasticity of the aggregate capital stock. That is, it depends on the strength of the *capital surplus* channel. In the *open* economy, the perfectly elastic aggregate capital stock maintains a constant return to wealth while ensuring relatively high average returns to labor. On the other hand, the *closed* economy with a more sluggish aggregate capital stock ensures that returns to wealth remain higher at the expense of lower marginal products of labor. Therefore, a household's preference over the elasticity of the aggregate capital stock depends on the relative contributions of labor income and capital income to total household income.

I find that the wealthier high skill households prefer the *closed* economy setting because the baseline calibration implies that the increase in asset returns more than compensates for the relative decline in labor market conditions in comparison to the *open* economy setting. Low skill immigration induces a welfare gain equal to 0.3% of initial consumption in the *closed* economy compared to just 0.17% in the open economy. Similarly, high skill immigration reduces welfare by an equivalent of 0.38% of initial consumption compared to 0.55% in the *open* economy.

On the other hand, for the less wealthy low skill households, the improvement in asset returns provided by the *closed* economy does not compensate for the worsened and more protracted labor market conditions. High skill immigration induces a welfare gain equal to 0.67% of initial consumption in the *open* economy compared to just 0.50% in the *closed* economy. Similarly, low skill immigration reduces welfare by an equivalent of 0.24% of initial consumption compared to 0.12% in the *open* economy.

Finally, a word on the difference between the reported welfare gains above, which are calculated at impact, and long run welfare gains, which are calculated once the economy has adjusted to its long run steady state. In the *open* economy, the perfectly elastic aggregate capital stock ensures that long run welfare coincides with the welfare change experienced on impact. In the *closed* economy, however, the transition to the new steady state is costly in the sense that long run welfare is higher than welfare on impact. This is because the temporary increase in returns to wealth incentivizes households to delay consumption, thereby allowing the accumulation of a higher level of long run wealth, which is reflected in higher long run consumption given that the long run labor market conditions are equivalent in both cases. Long run welfare therefore always dominates the measure of welfare on impact which accounts for the transition dynamics in a *closed* economy. When evaluating a potential immigration policy, however, policy makers ought to be concerned with the total change in welfare. Nevertheless the relative signs and magnitudes are unaffected.

This article is related to a vast empirical literature that examines the impact of immigration on the labor market outcomes of the host country by either exploiting variation in immigration stocks across local labor markets (Altonji and Card, 1991; Pischke and Velling, 1997), national level labor supply variation across education and experience groups (Grossman, 1982; Borjas, 2003), or natural immigration experiments (Card, 1990; Hunt, 1992). Unfortunately, a consistent conclusion still evades the profession. For example, Borjas (2003) and Borjas et al. (2008) find a large negative wage effect of immigration on natives, whereas Card (2009) and Ottaviano and Peri (2012) find a small and often positive effect. I build on a more recent related literature that seeks to answer this question within a general equilibrium framework (Ben-Gad, 2004, 2008; Liu, 2010; Chassamboulli and Palivos, 2013, 2014).

This article proceeds as follows. In section 1.2, I describe the theoretical model. In section 1.3, I describe the calibration procedure and the data sources used to inform the calibration. In section 1.4, I analyze the mechanisms through which migrants impact the labor market, wealth holdings, and native welfare. I present the results of the calibrated quantitative model in section 1.5. I conclude in section 1.6.

1.2 Model

There are four types of representative households, each consisting of a continuum of workers of the same type. Workers are either native-born (N) or immigrants (I) and each worker has either high (H) or low (L) skill. Members of each household pool their income in order to insure each other against individual employment risks. Consumption and investment decisions are therefore made at the level of the household. I denote the measure of type ij workers as Q_{ij}, where $i \in \{H, L\}$ denotes the skill level and $j \in \{N, I\}$ distinguishes native from immigrant workers. I normalize the total measure of workers to unity, $\sum_{ij} Q_{ij} = 1$. Immigration is modeled as an exogenous increase in the total measure of workers through an increase in either Q_{HI} or Q_{LI}. Time is discrete. All decisions are dynamic and time subscripts are omitted for notational clarity. Where appropriate, recursive notation is used to distinguish contemporary from future variables.

Production The final output numeraire good Y is produced by a representative firm using capital K and a composite input Z according to the following production function

$$Y = AK^{\alpha}Z^{1-\alpha} \tag{1.1}$$

where A is total factor productivity, α is the capital share of output and Z is a CES aggregate of different types of intermediate goods. The Cobb-Douglas functional form in (1.1) implicitly assumes that physical capital has the same degree of substitutability with each type of labor contained in Z. This structure coincides with the majority of the literature (Borjas, 2003; Ottaviano and Peri, 2012; Battisti et al., 2014).[3]

The composite input good Z is produced using an intermediate low-skilled good Y_L and an intermediate high-skilled good Y_H defined by

$$Z = \left(\gamma Y_L^{\rho} + (1-\gamma) Y_H^{\rho}\right)^{1/\rho}$$

where $-\infty < \rho \leq 1$ is a function of the elasticity of substitution σ_{HL} between the two skill groups ($\rho = 1 - 1/\sigma_{HL}$) and γ is a productivity parameter that determines the income share of the low-skilled good (Card and Lemieux, 2001). The breakdown of skill types is not an innocuous assumption. Different aggregation levels of education imply vastly different wage elasticities in the empirical literature, and as (Borjas, 2014, p. 127) states, "there is no convincing evidence on how best to pool" the intermediate goods in this setup. Nevertheless, the recognition that migration differentially impacts different skill groups is a key feature of the empirical literature and the dual decomposition should be viewed as a minimalist assumption.[4]

The representative firm rents capital from workers and purchases the intermediate goods from perfectly competitive firms that produce using linear functions of labor according to the following production functions

$$Y_i = E_{iN} + E_{iI}, \quad i \in \{L, H\} \tag{1.2}$$

where E_{ij} is the measure of employed workers of type ij.

[3]There are, however, a number of empirical studies that find that physical capital is more complementary toward high skill labor than toward low skill labor (Griliches, 1969; Berndt and Christensen, 1974; Denny and Fuss, 1977; Krusell et al., 2000). Chassamboulli and Palivos (2014) utilize these observations in order to simulate a larger immigration surplus from high skill immigration than from low skill immigration.

[4]This structure is identical to that used in Battisti et al. (2014) and similar to the structure used in Chassamboulli and Palivos (2014). Dustmann et al. (2013) avoid the aggregation issue altogether by assessing the impact of immigration along the entire wage distribution.

Embedded within Equation (1.2) is the implicit assumption that native-born and immigrant workers within each skill-level are perfect substitutes. Much of the disagreement in the empirical literature on the effect of migration on wages can be reduced to a disagreement regarding the degree to which migrants and natives of a given skill level are substitutable in production.[5] For example, Borjas et al. (2008) and Aydemir and Borjas (2007) estimate an effectively infinite elasticity and conclude that equally skilled natives and immigrants are perfect substitutes in their findings of a negative effect of migration on wages. The positive wage effects in Ottaviano and Peri (2012), on the other hand, are a result of their empirical findings that natives and immigrants are not perfect substitutes in production even within a skill group. However, Borjas et al. (2012) go on to show that the elasticity of substitution of around 20 estimated by Ottaviano and Peri (2012) was a result of an unusual regression specification which, once corrected, results in an elasticity close to infinity. I side with Borjas et al. (2012) and, indeed, with Battisti et al. (2014) in assuming that natives and migrants are perfect substitutes.

The intermediate goods market is perfectly competitive so prices p_i reflect their marginal contribution to the production of the final good. In particular,

$$p_L = AK^{\alpha}(1-\alpha)\gamma Y_L^{\rho-1}\left[\gamma Y_L^{\rho} + (1-\gamma)Y_H^{\rho}\right]^{(1-\alpha-\rho)/\rho} \tag{1.3}$$

$$p_H = AK^{\alpha}(1-\alpha)(1-\gamma) Y_H^{\rho-1}\left[\gamma Y_L^{\rho} + (1-\gamma)Y_H^{\rho}\right]^{(1-\alpha-\rho)/\rho} \tag{1.4}$$

Because the labor market is not competitive, the equilibrium prices of the intermediate goods are not equal to wages. This creates total non-zero profits for the representative intermediate goods firm of

$$d = p_H Y_H + p_L Y_L - E_{LN}w_{LN} - E_{LI}w_{LI} - E_{HN}w_{HN} - E_{HI}w_{HI} - \kappa_L v_L - \kappa_H v_H \tag{1.5}$$

[5]See Ottaviano and Peri (2012) and Borjas (2014) for a discussion.

where w_{ij} is the wage paid to worker type ij, κ_i is the cost of posting a vacancy to labor market i and v_i is the total number of vacancies posted to labor market i.[6] Profits are paid out as dividends to households, who are the shareholders, as explained below.

Finally, the representative final good firm rents capital on competitive markets at a price that reflects its marginal product

$$r = \alpha A \left(\frac{Z}{K}\right)^{1-\alpha} \tag{1.6}$$

Labor Markets There is a separate labor market for each skill type (H and L). Intermediate-good firms post skill-specific vacancies which do not distinguish between natives and immigrants, as usually required by law. The supply of each type of worker is given exogenously and natives and immigrants of the same skill-type compete for the same jobs. Four types of workers therefore compete in just two labor markets. The total supply of workers in labor market i is given by $Q_i = Q_{iN} + Q_{iI}$, $i \in \{H, L\}$. Immigration represents an exogenous change in the number of foreign-born workers, Q_{iI}.

The number of matches formed in each period is a standard function of the number of vacancies posted and the number of unemployed workers in each market. Defining labor market tightness as $\theta_i = v_i/U_i$, the matching function yields the vacancy-filling rate $\mu_i = \mu(\theta_i)$ and the job-finding rate $f_i = f(\theta_i)$ as

$$\mu_i = \xi \theta_i^{-\epsilon}, \quad f_i = \xi \theta_i^{1-\epsilon} \tag{1.7}$$

where ϵ and ξ have the usual respective interpretations of matching function elasticity and efficiency. Existing matches separate at the exogenous rate s_{ij}, which

[6] See below for an explanation of firm vacancy posting.

differs between natives and immigrants as well as across skill-types in order to generate the differential rates of unemployment across worker types that are observed in the data (Battisti et al., 2014). The law of motion of employment is

$$E'_{ij} = (1 - s_{ij})E_{ij} + f_i(Q_{ij} - E_{ij}) \tag{1.8}$$

The level of employment of type ij next period is equal to the sum of this period's employed workers that do not separate, and this period's unemployed workers who successfully find an employment match.

Firm Value Functions The resulting equations governing the value to a firm producing good i of an open vacancy V_i and of a filled job J_{ij} are as follows

$$V_i = -\kappa_i + q\Big[(1 - \mu_i)V'_i + \mu_i\Big((1 - \phi_i)J'_{iN} + \phi_i J'_{iI}\Big)\Big] \tag{1.9}$$

$$J_{ij} = p_i - w_{ij} + q\Big(s_{ij}V'_i + (1 - s_{ij})J'_{ij}\Big) \tag{1.10}$$

where κ_i is the cost of posting a vacancy in labor market i. The discount rate of the firm is q, which is the marginal rate of substitution of anyone with positive holdings of the firm, as explained below. The variable $\phi_i = U_{iI}/(U_{iI} + U_{iN})$ denotes the probability that any given filled vacancy is filled by an immigrant, which is defined as the share of immigrants among those searching for a job. An open vacancy is turned into a filled job at the rate μ_i.

Equation (1.9) demonstrates that the value to the firm of posting a vacancy in market i is equal to the probability of becoming matched with a worker in that market multiplied by the expected discounted gain from such an event less the cost of posting a vacancy. Importantly, the value of an open vacancy has no index j because firms cannot discriminate between native and immigrant workers when posting vacancies. Equation (1.10) demonstrates that the value of a match to the firm is equal to the sum of the contemporary production surplus of that match and the discounted expected value of the match persisting next period given that the match will separate with probability s_{ij}.

Free entry of firms implies that, in equilibrium, $V_i = 0$ for all i, which implies the following job creation condition

$$\kappa_i = q\mu_i\Big((1-\phi_i)J'_{iN} + \phi_i J'_{iI}\Big) \tag{1.11}$$

Firms post vacancies until the cost of doing so is equal to the discounted expected value of the surplus gained from posting a vacancy.

Asset Markets Households transfer wealth across time by investing in two assets: capital k which is used as an input for production, and equity x, which is a claim to the intermediate goods representative firm's profit. Because both forms of wealth holdings are risk free, no arbitrage equates the returns to each asset which, after normalizing the total amount of equity to one, yields the following relationship

$$1 + r' - \delta = \frac{d' + p'}{p}$$

where r is the return to capital and d is the dividend paid to the holders of equity, as given by Equation (1.5). Since capital and equity are equivalent from the household's viewpoint, the composition of the investment portfolio is irrelevant. I therefore simplify the asset structure by defining a composite asset a according to

$$a = (1 + r - \delta)k + (p + d)x$$

The price of the asset, q, is defined according to

$$q = 1/(1 + r' - \delta)$$

which is the inverse of the gross return to capital holdings or, equivalently, equity holdings. Simple algebra then implies that the following household budget constraint

$$C_{ij} + k'_{ij} + px'_{ij} = (1 + r - \delta)k_{ij} + (p + d)x_{ij} + E_{ij}w_{ij}$$

can be reduced to

$$C_{ij} + qa'_{ij} = a_{ij} + E_{ij}w_{ij}$$

This setup, which is equivalent to the asset structure proposed by Krusell et al. (2010), determines the appropriate firm discount rate in the presence of heterogeneous households.

In the closed economy, aggregation implies that

$$\sum_{ij} a_{ij} = (1 + r - \delta)K + (p + d) \tag{1.12}$$

where K is the aggregate capital stock used in production according to Equation (1.1). In the open economy, I make the standard small open economy assumption that the aggregate capital stock adjusts in order to satisfy Equation (1.13) in all time periods.

$$r^* = \alpha \frac{Y}{K} \tag{1.13}$$

where r^* is the world interest rate, which is exogenously set equal to the steady state value of the return on capital in the *closed* economy.

Households Although individual workers face unemployment risk, households of each type are comprised of a continuum of such workers who pool their income. Investment and consumption decisions are therefore made at the level of the household. The optimization problem of household ij is

$$W_{ij}(a_{ij};\omega) = \max_{a'_{ij},C_{ij}} \log\left(C_{ij} - b_{ij}E_{ij}\right) + \beta W_{ij}(a'_{ij};\omega') \tag{1.14}$$

subject to

$$C_{ij} + qa'_{ij} = a_{ij} + E_{ij}w_{ij} \quad \text{and} \quad a_{ij} \geq 0, \quad \text{given} \;\; a_{ij}(0)$$

where C_{ij} is total consumption of the household, ω represents the aggregate state which consists of all aggregate variables relevant to household decision making and $a_{ij}(0)$ is initial wealth holdings. The household chooses this period's consumption and next period's wealth holdings subject to its budget constraint and taking the evolution of employment as given according to Equation (1.8). The household receives labor income from its employed workers and asset income from wealth.

The choice of preferences is a special case of those described by by Greenwood et al. (1988). This specification allows an interpretation of b_{ij} as a worker's "outside option" in a manner that is consistent with the job search literature. The outside option is crucial in determining the total surplus of an employer-employee match, and therefore the dynamics of the labor market. In a canonical search model with linear preferences, the outside option can be interpreted as either the amount of utility sacrificed by a worker in gaining employment, or as a monetary unemployment benefit. Within the context of risk averse households, however, the equivalence between these interpretations breaks down. In particular, the amount of utility sacrificed in gaining employment depends on the marginal rate of substitution between leisure and consumption which in general depends on the wealth of a household. Similarly, the amount of utility derived from a monetary unemployment benefit will depend on the marginal utility of consumption, which also depends on wealth. As Krusell et al. (2010) demonstrate, the resulting labor market dynamics therefore depend on the distribution and level of wealth within the economy. The particular specification of preferences in Equation (1.14) ensures that the disutility derived from labor is independent of wealth, which is a well-known property of Greenwood et al. (1988) preferences.

The value to household ij of an extra worker is given by

$$W^E_{ij}(a_{ij};\omega) = \left(C_{ij} - b_{ij}E_{ij}\right)^{-1}\left(w_{ij} - b_{ij}\right) + \beta(1 - s_{ij} - f_i)W^E_{ij}(a'_{ij};\omega')$$

The transition of an additional worker from a state of unemployment to employment yields an immediate utility-adjusted benefit from the wage net of the outside option as well as an additional benefit derived from the implications for having another worker in the next period.

Wage Determination Wages are determined through bilateral Nash bargaining between households and the intermediate good firm, which divides the total surplus from an employment match between the two parties according to the following rule.

$$\max_{w_{ij}} \left(W^E_{ij}\right)^{1-\eta}(J_{ij})^{\eta} \tag{1.15}$$

where $\eta \in (0,1)$ represents the bargaining power of the worker. The solution to (1.15) yields the following wage equation

$$w_{ij} = \eta\left(p_i + qf_iJ'_{ij}\right) + (1-\eta)b_{ij} \tag{1.16}$$

which has the usual interpretation that the wage is equal to a weighted average of the worker's contribution to production and the outside option, where the weights are determined by the household's bargaining power. In the case where the household has no bargaining power ($\eta = 0$), the wage is simply the minimum amount required to incentivize the household to provide another worker, which is the outside option b_{ij}. In the case where the household has full power in wage negotiations ($\eta = 1$), the wage reflects the total amount of surplus to the firm generated by the employment match.

Equilibrium A competitive equilibrium in the *closed* economy consists of a set of allocations for each household $\{C_{ij}(t), a_{ij}(t)\}_{t=o}^{\infty}$, a set of prices $\{r(t), q(t), p(t), p_i(t), w_{ij}(t)\}_{t=0}^{\infty}$, a set of production stocks $\{K(t), Z(t), Y_i(t)\}_{t=0}^{\infty}$, a set of profits and vacancies $\{d(t), v_i(t)\}_{t=0}^{\infty}$, a set of matching rates $\{f_i(t), \mu_i(t)\}$, a set of employment and unemployment stocks $\{E_{ij}, U_{ij}\}_{t=0}^{\infty}$ and a set of labor market tightness measures $\{\theta_i\}_{t=0}^{\infty}$ such that

1. Given the prices, the profits, and the job finding rates, the household allocations solve the optimization problem of household ij.
2. Given the prices and the vacancy matching rates, the aggregate inputs and the vacancies solve the firms problem, where the profits are determined by (1.5).
3. The intermediate input markets clear. In particular, Equations (1.3) and (1.4) are satisfied.
4. The matching rates are determined by (1.7).
5. Wages are determined by the Nash bargaining condition (1.16).

6. The free entry condition (1.11) for each skill type i is satisfied.
7. The numbers of employed and unemployed workers satisfy (1.8).
8. Capital markets clear so that the sum of individual asset holdings is consistent with the aggregate capital stock. In particular, Equation (1.12) is satisfied.

A competitive equilibrium in the *open* economy coincides with that of a closed economy except that the capital market clearing condition 8 is replaced by

8′. Open capital markets ensure that the aggregate capital stock immediately adjusts to satisfy Equation (1.13) in all time periods.

Welfare I quantify the welfare effects of immigration in terms of compensating consumption differentials (Lucas, 2003). In particular, I define λ_{ij} as the percentage change in initial consumption of household ij that would leave the utility of that household unaffected by immigration. More formally, λ_{ij} solves

$$\sum_{t=0}^{\infty} \beta^t \log(\bar{C}_{ij}(1+\lambda_{ij}) - b_{ij}\bar{E}_{ij}) = \sum_{t=0}^{\infty} \beta^t \log(C_{ij}(t) - b_{ij}E_{ij}(t)) \tag{1.17}$$

where $\bar{C}_{ij}$ and $\bar{E}_{ij}$ are the initial steady state values of consumption and employment, respectively. A positive value of λ_{ij} corresponds to a welfare gain from immigration. In the presentation of the quantitative results in sections 2.3 and 1.5, I also present the steady state welfare gains λ^*_{ij} defined as the solution to

$$\sum_{t=0}^{\infty} \beta^t \log(\bar{C}_{ij}(1+\lambda_{ij}) - b_{ij}\bar{E}_{ij}) = \sum_{t=0}^{\infty} \beta^t \log(C^*_{ij} - b_{ij}E^*_{ij}) \tag{1.18}$$

where C^*_{ij} and E^*_{ij} are the long run steady state values of consumption and employment, respectively. The values of λ_{ij} and λ^*_{ij} differ because the former incorporates the welfare effects of the transition dynamics whereas the latter does not. Sections 2.3 and 1.5 demonstrate that, in general, the transition dynamics are costly so that $\lambda_{ij} < \lambda^*_{ij}$.

Computation Because of household heterogeneity, a one-to-one mapping between a household-level state variable a_{ij} and the aggregate state, which includes aggregate capital, does not exist. Because household decisions rely on the aggregate state, the evolution of which must be consistent with the decisions of other households, the model cannot be solved analytically. I use the following shooting algorithm to solve for the transition dynamics which ensures that the value of the post immigration experiment steady state asset holding positions are consistent with the asset-accumulation dynamics of the pre-reform equilibrium and the dependency of the wealth distribution on initial asset holdings (Mendoza and Tesar, 1998; Gorodnichenko et al., 2012).

For a given calibration, the resulting steady state values of labor market variables after an immigration shock can be determined analytically. This is a result of the preferences described in Equation (1.14) which ensure that the disutility derived from employment is independent of a household's wealth, and therefore also independent of the transition dynamics. The final steady state values of aggregate capital $\bar{K}$ and labor market tightness variables, $\bar{\theta}_L$ and $\bar{\theta}_H$, can be derived analytically.

The computation algorithm for the *closed* economy is as follows.

1. For a given sufficiently long number of time periods T, choose a sequence of aggregate capital stocks $\mathbf{K} = \{K_0, \cdots, K_T = \bar{K}\}$.
2. Choose a sequence of market tightness parameters for both the low-skill and high-skill labor markets $\Theta_L = \{\theta_{L0}, \cdots, \theta_{LT} = \bar{\theta}_L\}$, $\Theta_H = \{\theta_{H0}, \cdots, \theta_{HT} = \bar{\theta}_H\}$.
3. Calculate the resulting sequence of job finding and vacancy filling probabilities using Equation (1.7), employment stocks using Equation (1.8), factor prices using Equations (1.1)-(1.4) and firm value functions using Equation (1.10).
4. Using the values calculated in step 3, determine whether the job-creation conditions (1.11) are satisfied. If not, update Θ_L and Θ_H and return to step 3. Otherwise, proceed to step 5.
5. Use the sequence of wages and asset returns to solve each household's optimization problem. Check that the sum of all resulting household asset holdings are consistent with the level of the aggregate capital stock in each period according to (1.12). If not, update $\mathbf{K}$ and return to step 1. Repeat until convergence.

The computation algorithm for the *open* economy is simpler as it does not require the *outer* aggregate capital loop.

1. Choose a sequence of market tightness parameters for both the low-skill and high-skill labor markets $\Theta_L = \{\theta_{L0}, \cdots, \theta_{LT} = \bar{\theta}_L\}$, $\Theta_H = \{\theta_{H0}, \cdots, \theta_{HT} = \bar{\theta}_H\}$.
2. Calculate the resulting sequence of job finding and vacancy filling probabilities using Equation (1.7), employment stocks using Equation (1.8). Calculate

the resulting aggregate level of capital using (C.3.2) and the assumption that r remains constant in each period. Calculate the resulting factor prices using Equations (1.1)-(1.4) and firm value functions using Equation (1.10).

3. Using the values calculated in step 2, determine whether the job-creation conditions (1.11) are satisfied. If not, update Θ_L and Θ_H and return to step 2. Repeat until convergence.

1.3 Data and Calibration

Section 1.4 demonstrates that the direction and size of the effects of immigration on the labor market and welfare crucially depend on the parameter values. In order to generate quantitative results for the effect of immigration, I calibrate the model to match key features of the United States economy over the last decade. I define a time period as one quarter.

The model is characterized by 23 parameters which consist of the preference parameters $\{\beta, b_{ij}\}$, the labor force measures $\{Q_{ij}\}$, the production parameters $\{A, \rho, \alpha, \gamma\}$, the matching function parameters $\{\xi, \epsilon\}$, the workers' bargaining power η, the capital depreciation rate δ, the initial shares of wealth $\{a_{ij}(0)\}$, the vacancy posting costs $\{\kappa_i\}$ and the separation rates $\{s_{ij}\}$. I partition the parameters into two sets - $\Theta_1 = \{Q_{ij}, \beta, \rho, \alpha, \kappa_H, \delta, \epsilon, \eta, A, b_{iI}, a_{ij}(0)\}$ and $\Theta_2 = \{\kappa_L, b_{iH}, s_{ij}, \xi, \gamma\}$. I calibrate the parameters in Θ_1 by either directly matching values with an empirical counterpart, by taking values common in the literature, or by normalization. I jointly calibrate the parameters in Θ_2 by matching moments.

I set the risk free steady state rate of return in the model equal to the real interest rate calculated by Chassamboulli and Palivos (2014) who use an inflation adjusted measure of the 30-year treasury constant maturity bond rate of 4.76% per annum, which implies a quarterly discount factor of $\beta = 0.988$. In the case of the open economy, I fix the world interest rate at this level. I set the elasticity of the matching function, ϵ, equal to 0.5, which is a commonly used value within the range of estimates reported in Pissarides and Petrongolo (2001). Following common practice, I set the Nash bargaining parameter η equal to 0.5 in accordance with the efficiency condition proposed by Hosios (1990).

The elasticity of substitution between high and low skilled workers crucially depends on the definition of each skill group. For example, Card (2009) finds that workers with less than a high school education are perfect substitutes for those with a high school education, regardless of age and experience. On the other hand, the elasticity of substitution between workers with and without a college education has consistently been estimated to be around 2 (Katz and Murphy, 1992; Angrist, 1995; Johnson, 1997; Ottaviano and Peri, 2012). I therefore define high skilled workers to be those who have completed college, and set $\rho = 1 - \frac{1}{\sigma_{HL}} = 0.5$, which corresponds to an elasticity of substitution of $\sigma_{HL} = 2$.

I set the quarterly value of depreciation δ equal to 0.0182 which is equivalent to the monthly rate of 0.0061 in Chassamboulli and Palivos (2014). I set the capital share of income α equal to the standard 0.33. I choose the labor force shares Q_{ij} to match their empirical counterparts, which I calculate using monthly Current Population Survey (CPS) data downloaded from the Integrated Public Use Microdata Samples (IPUMS) (Flood et al., 2015). I define immigrants as those workers born outside the United States and high skilled workers as those with at least a college degree.[7] Figure A.1 presents the seasonally adjusted time series of the respective labor force shares over the decade from January 2005 to December 2014.

[Insert Figure A.1 about here]

Low-skilled native workers account for the majority of the United States labor force at an average of 57.0% over the sample period, followed by high-skilled natives at 26.1%, low skilled immigrants at 11.9% and high skilled immigrants at 5%. I directly match the values of Q_{ij} to these figures after normalizing the total population $\sum_{ij} Q_{ij} = 1$.

I estimate the respective initial wealth shares of each worker type, $a_{ij}(0)$, using the 2008 Survey of Income and Program Participation (SIPP), which consists of a short, rotating panel of 8 to 12 waves of data collected every 4 months for around 36,700 households in the United States. The survey contains core questions that are common to each wave in addition to topical questions about particular topics that are not updated in each wave. I use waves 4, 7 and 10, which contains information on both household assets (in the topical module) and the birthplace and education level of the respondent (in the core) over the 2009 to 2011 period. As explained by Cobb-Clark and Hildebrand (2006), more commonly used datasets containing wealth and asset information are less appropriate for considering the allocation of wealth across immigrant and skill groups.[8] The Survey of Consumer Finances, for example, does not identify foreign-born individuals whereas the de-

[7] In the IPUMS dataset, these definitions correspond to the following variable values: `bpl`=9900 (foreign born), `educ99`>14 (college educated). A detailed description of these calculations is available upon request.

[8] Ben-Gad (2008) calibrates his model using the Survey of Consumer Finances to identify the ratio of wealth between high and low skilled workers. He does not, however, distinguish between native born and immigrant wealth.

sign of the Panel Study of Income Dynamics does not include any immigrants who arrived in the United States after 1968.[9]

Table A.1 presents the wealth shares of each worker type in each wave of the 2008 SIPP. On average between 2009 and 2011, native high skilled workers owned 86.7% of household wealth, followed by 8.5% for High skilled immigrants, 3.6% for low skilled natives and just 1.2% for low skilled immigrants. Note that the distribution of wealth is more skewed toward high skilled workers than these figures suggest, given that high skilled workers make up a lower amount of the United States labor force than their low-skilled counterparts, as demonstrated in Figure A.1.

[Insert Table A.1 about here]

I normalize the high-skill vacancy posting cost κ_H to one and I set A in order to normalize steady state output, Y, to one. Finally, I normalize the native outside options b_{iN} to zero. This simplifies the interpretation of the welfare results because it ensures that native born welfare is fully determined by consumption fluctuations rather than a combination of consumption and labor supply fluctuations.

The parameters in $\Theta_2 = \{b_{iN}, s_{ij}, \gamma, \kappa_L, \xi\}$ are jointly determined by 9 moment matching conditions. I demonstrate in Appendix A.3 that the moment matching procedure can be reduced to a system of nine simultaneous equations in nine unknowns which allows me to exactly match the nine moments. A subjective weighting of each moment is therefore not required.

[9] Although in 1990 the PSID added 2,000 Latino households consisting of families originally from Mexico, Puerto Rico, and Cuba.

The first three moments are the respective average ratios of the wages of each worker type with respect to the wages of high skill natives over the January 2005 to December 2014 sample period. Following much of the literature (Card, 1990), I obtain wage data from the outgoing rotation groups of the CPS contained in the IPUMS data. Figure A.2 plots the time series of nominal hourly wages (left hand panel) as well as the resulting ratios with respect to high skilled native wages (right hand panel). Figure A.2 demonstrates two main points. The first is that within each skill group, native born workers earn a premium over their immigrant counterparts. Similarly, within nativity groups, high skilled workers earn a premium over their low skilled counterparts. The wage ratio with respect to high skilled natives is, on average over the sample period, 0.9618 for high-skilled immigrants, 0.651 for low-skilled natives and 0.588 for low skilled immigrants.

[Insert Figure A.2 about here]

Unemployment rates of each worker type are the next four moment targets. Using the IPUMS data, Figure A.3 plots the respective time series of unemployment rates over the sample period. High skilled natives experienced an average unemployment rate of 3.4% while high skilled immigrants experiences a rate of 4.5%. Low skilled workers regardless of nativity faced a much higher unemployment rate of 8.7% for native workers. Interestingly, low-skilled immigrants experienced a lower average unemployment rate of 8.1%.

[Insert Figure A.3 about here]

Finally, I target the respective job finding rates within each labor market. The IPUMS data contains information regarding the employment of individuals in consecutive months, which allows me to construct time series for the gross flows of workers in each skill group between employment and unemployment. I use these gross flow measures to calculate job finding rates according to the methodology of Shimer (2012), which accounts for aggregation bias by exploiting a continuous time environment.

Figure A.4 plots the series of instantaneous job finding rates for high skilled (solid line) and low skilled (dashed line) workers over the last decade. Over the entire period, high skilled workers have benefited from higher job finding rates of 0.27 compared to 0.245 for low skill workers.

[Insert Figure A.4 about here]

The calibration results and targets are summarized in Table A.2.

[Insert Table A.2 about here]

1.4 Analysis

In this section, I analyze the theoretical mechanisms through which immigration affects the labor market and welfare outcomes of native workers. I isolate each mechanism using special cases of the parameter values.

1.4.1 Basic Model

In this section, I equate the outside options and separation rates of all workers ($b_{ij} = 0$, $s_{ij} = s_{HN}$). I also assume that high and low skill workers are perfect substitutes ($\rho = 1$), have equal productivity ($\gamma = 0.5$) and that hiring costs are homogeneous across labor markets ($\kappa_L = \kappa_H = 1$). Production is therefore reduced to a standard Cobb-Douglas model with homogeneous labor and the effect of immigration is to simply increase the supply of that labor. Table A.3 lists the percentage changes for key variables in response to a 1% increase in the labor force caused by either low skill immigration (columns 1 - 2) or high skill immigration (columns 3 - 4) under the assumption that all workers hold the same amount of wealth. Because wealth holdings and the accumulation of aggregate capital plays a large role in determining the welfare effects in this model, I distinguish between two extreme scenarios regarding the degree to which domestic asset markets are open to foreign capital flows. Columns 1 and 3 represent an *open* economy that is fully open to foreign capital flows, in which case the return to asset holdings is unaffected by domestic factors. Columns 2 and 4 represent a *closed* economy in which the aggregate capital stock is fully determined by the asset accumulation decisions of domestic households.

[Insert Table A.3 about here]

Table A.3 demonstrates that an influx of immigrants of either skill level has no effect on wages, unemployment or goods prices in the long run after capital adjusts to leave factor prices unaltered. A general property of this model is that the steady state values of the labor market variables do not depend on the transition dynamics. This is a direct consequence of the Greenwood et al. (1988) preferences specified in Equation (1.14), which ensure that worker outside options, and therefore labor market dynamics are not affected by household wealth. The steady state outcomes of these labor market variables do not, however, fully determine the overall welfare effects. This is because consumption decisions, which ultimately affect welfare, depend on asset accumulation as well as the dynamics of labor market variables.

Columns 1 and 3 of Table A.3 show that when capital immediately adjusts to leave asset returns unaltered, the present value of labor income is also unaltered and therefore utility is unaffected by immigration, either on impact or in the long run. Thus, the welfare implications derived from a static neoclassical model with a perfectly elastic supply of capital coincide with my framework under the assumptions of this section when capital markets are open to foreign investment.

However, when the economy is *closed*, the immigration-induced increase in labor supply temporarily increases the marginal product of capital and therefore the rate of return to wealth holdings. This incentivizes households to accumulate wealth. Columns 2 and 4 demonstrate that there is a long-run welfare gain equal to a 0.24% permanent increase in the level of initial consumption as a result of the accumulation of wealth over the transition period. This long run welfare gain, however, is almost completely offset by the reduction in labor income as labor market conditions temporarily worsen over the transition.[10] Table A.3 demonstrates that the transition costs reduce the welfare gain by 99% (0.24 vs 0.0006). In this scenario, the effect of immigration on the welfare of native born workers is similar in an open or closed economy.

[10]This difference in long run utility gain between closed and open economies has been examined in the context of capital tax reforms by Mendoza and Tesar (1998).

Figure A.5, which plots the adjustment path of labor market tightness, unemployment and wages of native workers in response to an immigration-induced 1% increase in the total labor force, helps to illustrate why the welfare results differ between the open and the closed economy cases. The red dashed lines illustrate the behavior of variables in the *open* economy, where capital immediately adjusts to equate asset returns. Because labor is homogeneous, the constant rate of return on capital implies a constant marginal product of labor. There is therefore no change in the hiring incentives of firms or wages.

[Insert Figure A.5 about here]

The blue solid lines represent the *closed* economy. Immigration reduces the marginal product of labor because the aggregate capital stock is sluggish to respond. This reduces the bargaining position of workers, which negatively impacts wages and unemployment until steady prices are restored. Why, then, is the overall welfare gain to natives positive (6×10^{-4}), despite the reduction in the preset value of labor income? Because households also generate asset income. Over the transition, the temporary increase in asset returns caused by the immigration-induced increase in the marginal product of capital more than makes up for the loss in labor earnings.

1.4.2 Capital Surplus Channel - Heterogeneous Wealth Holdings

Table A.4 presents the equivalent results to Table A.3 with the exception that household wealth shares are consistent with the empirical observations presented in section 1.3. The neutral long run effects on the labor market are unaltered because of the preference specification in Equation (1.14) that ensures that each worker's outside option is independent of wealth. However, when the economy is *closed*, the welfare effects of immigration are affected by initial wealth holdings. In particular, the long run welfare gains (0.41% vs 0.11%) and total welfare gains (0.17% vs -0.13%) are now much larger for high-skilled native households. High skilled native households begin with a much larger share of national wealth, as demonstrated in Table A.1, which means that they are less reliant upon labor income. Therefore, the reduction in the present value of labor income caused by immigration can be "buffered" by a sufficiently large amount of wealth. The labor income of low skilled households, however, dominates asset income which results in a welfare loss for these households.

[Insert Table A.4 about here]

1.4.3 Price Channel - Imperfect Substitution across Skill Groups

In this section, I analyze the case in which all workers remain identical in terms of outside options ($b_{ij} = 0$), separation rates, ($s_{ij} = s_{HN}$) and productivity ($\gamma = 0.5$) but that high and low skill workers are no longer perfect substitutes ($\rho = 0.5$), despite hiring costs remaining the same across labor markets ($\kappa_L = \kappa_H = 1$). Under this scenario, immigration affects the relative skill composition of the labor force, and therefore alters the relative prices of each intermediate good p_i. Equation (1.19) presents the steady state value to a firm of an employment match with worker ij.

$$J_{ij} = \frac{(1-\eta)(p_i - b_{ij})}{1 - \beta(1 - s_{ij} - \eta f_i)} \tag{1.19}$$

Equation (1.19) demonstrates that an increase in p_i increases the value to the firm of a match in labor market i, which incentivizes hiring and leads to more employment in that labor market. The improvement in workers' bargaining positions also positively influences wages. The corresponding results in Table A.5 are consistent with this insight. Low skill immigration (columns 1 - 2) increases (decreases) the wages of high (low) skill workers by 0.44% (0.33%), which are reflected in similar changes to goods prices. This is the redistributive effect of skill-biased immigration that is predicted by classical factor demand theory (Borjas, 2014). In a competitive setup, the effect on prices and wages coincide, but the labor search frictions in the model create a wedge between these goods and labor prices. Nevertheless, these results are consistent with long run wage elasticities of 0.3 - 0.4 that are estimated within competitive frameworks (Borjas, 2003; Ben-Gad, 2008).

[Insert Table A.5 about here]

The non-Walrasian labor market framework also allows the analysis of unemployment effects. The change in producer surplus caused by the price effects of immigration also alter the vacancy posting decisions of firms. Thus, low skill immigration reduces (increases) high (low) skill unemployment. As a result of these labor market changes, low skill immigration unsurprisingly increases (reduces) the present value of labor income for high (low) skill workers. For both types of workers, labor income is superior in the *open* economy because a more responsive aggregate capital stock leads to higher levels of the marginal products of labor over the transition period. Figure A.6, which plots the transition dynamics of labor market variables in response low skill immigration, demonstrates this point. The *open* economy responses exhibit higher levels of wages and lower levels of unemployment over the transition period. Note that, in contrast to Figure A.5, the red dashed line that represents the economy with open capital flows is not a flat line. Within an environment with two skill groups, a constant rate of return to capital no longer implies a constant marginal product of labor. Instead, the relative marginal products adjust according to the skill composition of the employed labor force. Because search frictions ensure that employment stocks adjust gradually, so too do marginal products and therefore wages and unemployment.

[Insert Figure A.6 about here]

High (low) skill households experience welfare gains (losses), both in the long run and after accounting for transition costs. Long run welfare gains are always higher in the *closed* economy compared to the *open* economy because the wealth accumulation over the transition period results in higher levels of asset income in the long run while long run labor income are unaltered across the *closed* and *open* economies. The total welfare effects, however, depend on whether the reduction in the present vale of labor market earnings are offset by higher asset returns over the transition period.

The qualitative results are reversed in columns 3 - 4. High skill immigration worsens (improves) the labor market outcomes of high (low) skill workers. As a result, high (low) skill households experience welfare losses (gains). The magnitudes of the changes induced by high skill immigration are larger than low skill immigration. This is because the population of high skilled workers is much smaller than low skilled workers, as presented in Section 1.3 and Figure A.1. As a result, a 1% increase in the labor force that arises out of an increase in high skill workers distorts the skill composition of the labor force to a larger degree.

1.4.4 Hiring Cost Channel - Heterogeneous Workers

In this section, I analyze the case in which high and low skill workers are perfect substitutes ($\rho = 1$) but where workers differ according to their outside options (b_{ij}) and separation rates (s_{ij}).[11] Under these assumptions, an increase in the number of immigrants increases the probability, ϕ_i, that a given vacancy within each labor market is filled by an immigrant. Native workers command a wage premium over their immigrant counterparts due to having higher outside options. This means that an increased likelihood of hiring an immigrant lowers the expected wage to be paid by a firm and therefore raises the expected value of posting a vacancy. Firms are incentivized to post vacancies, which increases employment and wages via an increase in the worker's bargaining position. Chassamboulli and Palivos (2014) and Battisti et al. (2014) study this *hiring cost* channel within a static setting.

Table A.6 demonstrates that a low-skill immigration-induced 1% increase in the labor force (columns 1 - 2) lowers the expected cost of hiring in the low skill market and, through its effect on hiring incentives, lowers long run unemployment by 0.37%. The tighter labor market conditions increase the bargaining position of low skill workers, which also results in higher (0.04%) long run wages. Wages and unemployment in the high skill market are unaffected in the long run because there is no skill-composition effect of the type explored in section 1.4.3, and the likelihood of hiring an immigrant is unchanged in the high skill market.

[11] Because equilibrium conditions cannot be satisfied with equal productivity and hiring costs within each labor market, I also set γ and κ_L to their respective calibrated values.

[Insert Table A.6 about here]

Figure A.7, which presents the transition dynamics of the labor market variables in response to low skill immigration, demonstrates that the neutral long run labor market effects mask substantial short run fluctuations in the *closed* economy. The relatively sluggish response of capital in comparison to the *open* economy keeps the marginal product of labor below its steady state level. This reduces the surplus to firms in the high skill market, which temporarily raises unemployment and reduces wages. Thus, the present value of labor earnings for high skill workers decreases, as demonstrated in Table A.6. In the *open* economy, however, the high skill labor market is unaffected, and behaves as it does in the case of the basic model presented in section 1.4.1. The reduction in the marginal product of labor over the transition period is dominated by the reduction in hiring costs for low skill workers. Thus, low skill labor earnings increases.

[Insert Figure A.7 about here]

The qualitative welfare impacts of immigration reflect the labor earnings effects. In particular, low (high) skill immigration reduces welfare for high (low) skill workers in the *closed* economy, as the *capital surplus* gains from wealth holdings are outweighed by the negative impact on labor earnings. However, the hiring cost effect ensures that low (high) skill households benefit from low (high) skill immigration. Finally, the welfare of high (low) skill workers is unaffected by (low) high skill immigration in the *open* economy.

1.5 Results

Table A.7 presents the main results. Low skill immigration improves the long run wages of high skill workers by 0.45% and reduces the long run wages of low skill workers by 0.27%. These figures can be interpreted as long run wage elasticities and are roughly consistent with the wage elasticity estimates of between -0.3 and -0.4 in frameworks with competitive labor markets (Borjas, 2003; Ben-Gad, 2008), as well as the empirical literature. For example, in their meta analysis of 344 empirical estimates of the impact of immigration on wages, Longhi et al. (2005) find an average elasticity of -0.12. Thus, it is the traditional *price* channel that dominates the *hiring cost* channel in wage setting, which is also reflected in the magnitudes of the corresponding changes to goods prices. The relative magnitudes of these channels in wage setting is consistent with the findings of Chassamboulli and Palivos (2013). I find that high skilled immigration reduces the long run wages of high skilled workers by 0.91% and improves the wages of low-skilled workers by 0.67%. As discussed in section 1.4.3, the larger elasticities caused by high skill immigration are primarily a result of differences in the size of the respective labor forces. Table A.2 records that high skill workers only account for approximately 30% of the labor force. Thus, for a given immigration-induced increase in the population, the skill composition of the labor force is more dramatically affected if that increase is comprised of high skill workers.

[Insert Table A.7 about here]

Immigration, regardless of its skill composition, lowers long run unemployment. I find a long run "unemployment elasticity" of between -0.04 and -0.30, which indicates that the *hiring cost* channel dominates the *price* channel in the determination of employment. The relative magnitudes of these channels in the determination of employment outcomes is also consistent with the findings of Chassamboulli and Palivos (2013). Low skill immigration, for example, lowers the productivity of low skill workers which is reflected in a reduction in low skill wages. However, this reduction in productivity is offset by a corresponding reduction in hiring cost, which, on balance, promotes hiring activity. These findings are also somewhat consistent with the empirical literature. In their meta analysis of 165 estimates of the impact of immigration on employment, Longhi et al. (2006) find that employment of the native born reduces by an average of 0.03% in the US, and -0.84% in countries other than the US, but with a range from -3.9% to 6.2%. In the United States there appears to be a small net job creation effect, which is consistent with my findings, while European labour markets have a 'crowding out' effect.

In the cases where immigration reduces wages but improves employment, it is the former that dominates in terms of the present value of labor earnings, calculated by discounting labor income by the steady state return on wealth. For example, low skill immigration reduces the present value of labor earnings for low skilled households by 0.12% in the *open* economy, despite also reducing the long run unemployment rate of low skill workers by 0.30%.

I now turn toward the welfare effect of capital stock elasticity. As the economy responds to an immigration influx, there is a transition period during which the labor market adjusts to its new steady state equilibrium. The dynamic response of labor market variables to low skill immigration is presented in Figure A.8, which demonstrates that the dynamics crucially depend on the responsiveness of the aggregate capital stock. The relatively sluggish response of the capital stock in the *closed* economy through heightened domestic savings ensures a longer transition period than in an *open* economy, in which capital is constantly imported to leave its rate of return constant. The economy takes approximately one decade (40 quarters) to reach the steady state in the *open* economy compared to around 40 years (160 quarters) in the *closed* economy. These transition periods are consistent with those found in the neoclassical framework of Ben-Gad (2008), which indicates that capital frictions are more important than labor market frictions in determining the long run adjustment of the economy to immigration.

[Insert Figure A.8 about here]

Not only is the transition period more protracted in the *closed* economy, but labor productivity in any given period is lower in comparison to the *open* economy. Consequently, wages are always lower, and unemployment always higher in any given period following immigration until the steady state is reached in the *closed* economy. The present value of labor earnings is therefore always lower in a *closed* economy. Table A.7 shows that, for example, low skill immigration raises the present value of high skill household labor earnings by 0.45% in an *open* economy but just 0.31% in a *closed* economy. The ultimate effect on welfare, however, also depends on how wealth income changes between the *open* and *closed* economies. The welfare results across columns 1 and 2 demonstrate that high skill households benefit from low skill immigration to a much larger degree in the *closed* economy (0.30% vs 0.17%). This indicates that the gains from asset income over the more protracted transition period offset the corresponding reductions in labor income. However, the opposite is true for the less wealthy low skill households. Because low skill households derive a larger proportion of their income from labor, any gains in asset returns are more than offset by the corresponding reduction in labor earnings. Thus, low skill households experience a welfare gain from high skill immigration of 0.67% in the *open* economy compared to just 0.50% in the *closed* economy.

1.6 Conclusion

Current migration policies are among the largest economic distortions in the world economy. Driving these policies are concerns for the welfare effects of immigration on native-born workers. Understanding these effects is therefore crucial not just for native-born workers, but also for the substantial proportion of the world population who wish to migrate.

In this article, I examine the welfare effects of immigration within a general equilibrium framework calibrated to match key features of the United States economy over the last decade. I construct a fully dynamic search and matching model in which migrants and natives differ according to their outside options, separation rates, wealth holdings and skill composition.

Migrants affect native-born welfare by shifting the skill composition of the labor force, by lowering the hiring cost of firms, by temporarily raising the rates of returns to wealth holdings, and by temporarily lowering the average marginal product of labor. I find that immigration of one skill type lowers the long run wages of that skill type, raises the long run wages of the other skill type, and reduces the long run unemployment rates for all workers. The overall effect of the changes in labor market conditions caused by high (low) skill immigration is to reduce the discounted present value of labor income for high (low) skill households and increase the discounted present value of labor income for low (high) skill workers.

The magnitude of the changes in the present value of labor earnings crucially depends on the responsiveness of the aggregate capital stock to immigration. I find that an open economy, in which capital is constantly imported to leave its rate of return constant, significantly improves the impact of immigration on labor earnings in comparison to a closed economy in which the response of the capital stock is relatively sluggish. The closed economy, however, exhibits higher rates of return to wealth.

I find that low (high) skill immigration results in a welfare loss for high (low) skill native households and a welfare gain for low (high) skill native households. The welfare of high skill households, which are wealthier than their low skill counterparts, is improved in a closed economy in comparison to the open economy. On the other hand, the less wealthy low skill households prefer the open economy because labor rather than wealth is their dominant source of income. By computing the full transition dynamics of the economy as it adjusts to immigration, this article suggests that wealth holdings are a key determinant of the welfare effects of immigration.

CHAPTER 2

WELFARE ANALYSIS IN AN EXTENDED HARRIS-TODARO MODEL: AN APPLICATION OF THE ATKINSON THEOREM

2.1 Introduction

Most people in the developing world derive all their income from employment (World Bank, 2012). The structure of labor markets, and the policies enacted within them, therefore dramatically affect the lives of the poor. The multi-sector labor market model of Harris and Todaro (1970) (HT) remains the basic framework for a vast literature devoted to analyzing labor market policies in developing economies. These analyses primarily focus on wages and unemployment, while ignoring the welfare consequences of labor market policies. One reason for this oversight is that it is generally difficult, within such models, to draw robust welfare conclusions that do not critically depend on the specific welfare criterion adopted (Temple, 2005). For example, in one of the few welfare economic analyses in this literature, Fields (2005) shows that the welfare consequences of various labor market policies are ambiguous even when restricting the analysis to abbreviated welfare functions.

In this article, I derive welfare conclusions that are both unambiguous and robust to alternative specifications of welfare criteria. I do so by exploiting the classic Atkinson (1970) welfare theorem, which specifies conditions under which one can make welfare statements for an extremely broad class of social welfare functions. The usefulness of this theorem is generally limited by its lack of applicability because its conditions are seldom satisfied in practice (Dutta, 2002). Thus, the direct application of the Atkinson (1970) theorem can itself be considered an additional contribution of this article.

I consider the generalized HT framework of Fields (1989), which incorporates two of the more important subsequent extensions in the literature – informal sector dualism and on-the-job search. Within this framework, I analyze two labor market policies. The first, modern sector enlargement (MSENL), was the primary policy considered by HT and is now the benchmark policy for analyzing and comparing the structure of labor market models within the literature. The second, increasing the efficiency of on-the-job search from the urban informal sector (IEOS), is a novel policy enabled by informal sector dualism and on-the-job search.

I demonstrate that MSENL causes a Lorenz worsening of the income distribution and IEOS causes a Lorenz improvement. This is a novel result in itself given that policies within HT frameworks do not generally result in income distributions with non-intersecting Lorenz curves (Temple, 2005). I also demonstrate that both MSENL and IEOS do not alter the mean of the income distribution. These properties satisfy the strict conditions of the Atkinson (1970) theorem, which I then invoke to conclude that MSENL reduces social welfare and IEOS improves social welfare for all anonymous, increasing and Schur-concave social welfare functions.

The chapter proceeds as follows. In section 2.2, I describe the salient features of the extended Harris-Todaro model of Fields (1989). I conduct the welfare analysis in section 2.3 and conclude in section 2.4.

2.2 Model

Fields (1989) defines three employment sectors – the urban modern sector (M), the urban traditional sector (T), and the agricultural sector (A). The urban modern sector pays the highest wage, W_M, which is exogenously set above the market clearing level by a combination of institutional and market forces. Thus, all workers aspire to jobs in this sector, but employment is fixed at a level E_M. Workers may elect to search for these jobs by opting for one of three search strategies.

Strategy I is identical to the Harris and Todaro (1970) (HT) strategy of directing all effort toward search while being openly unemployed. Strategy II is to search part time while accepting low-wage employment in the land-abundant agricultural sector at a fixed wage W_A. Strategy III is to search part time from the urban traditional sector, while accepting low-wage employment at an endogenous wage W_T, assuming that a fixed amount of total earnings in the traditional sector, Q_T, is allocated evenly across workers, L_T, such that $W_T = \frac{Q_T}{L_T}$.

The probability of finding a job using strategy I is π, which is determined endogenously and described in Equation (2.1) below. The expected earnings from this strategy are therefore $V_I = \pi W_M$. Workers who adopt search strategy II face a reduced probability $\theta\pi$ of obtaining a high-wage job, where $1 > \theta > 0$, because such workers can only devote part of their time to searching while maintaining agricultural employment. Expected earnings from strategy II are $V_{II} = W_M\theta\pi + W_A(1 - \theta\pi)$. Workers who opt for strategy III face a probability $\varphi\pi$ of finding a job in the urban modern sector. The corresponding expected earnings are $V_{III} = W_M\varphi\pi + W_T(1 - \varphi\pi)$. It is assumed that $1 > \varphi > \theta > 0$ because the geographical distance between the agricultural and urban sector means that agricultural workers experience substantial inconvenience when searching for a job compared to traditional workers located in urban areas. The HT model is obtained within this framework by removing the urban traditional sector ($Q_T = 0$) and on-the-job search ($\varphi = \theta = 0$).

Denoting the number of workers electing search strategy $i \in \{I, II, III\}$ by L_i, the probability of finding a job using strategy I is defined as

$$\pi = \frac{E_M}{L_I + \theta L_{II} + \varphi L_{III}} \tag{2.1}$$

The probability of finding a modern sector job is a function of the *ex-ante* number of workers who initially choose each search strategy, rather than the resulting *ex-post* allocations of workers across the three employment sectors. The relationships between the ex-post and ex-ante allocations are described by Equations (2.2)-(2.5).

$$L_M = E_M = \pi(L_I + \theta L_{II} + \varphi L_{III}) \tag{2.2}$$

$$L_A = L_{II}(1 - \theta\pi) \tag{2.3}$$

$$L_T = L_{III}(1 - \varphi\pi) \tag{2.4}$$

$$U = L_I(1 - \pi) \tag{2.5}$$

Equation (2.2) demonstrates that modern sector employment L_M is fixed at E_M, which is comprised of the successful job searchers from each of the search strategies. Equations (2.3) - (2.5) demonstrate that agricultural employment L_A, urban traditional sector employment L_T, and open unemployment U are determined by the number of workers who are unsuccessful in obtaining high-wage employment from search strategy II, III and I, respectively. The ex-ante and ex-post labor market clearing conditions are given by

$$L = L_I + L_{II} + L_{III} = L_M + L_T + L_A + U \tag{2.6}$$

The L workers in the economy initially allocate themselves across the three search strategies. Once the labor market clears, workers find themselves in one of the four employment states. Search strategies are chosen in order to maximize expected earnings. An interior solution to this problem therefore requires that all three search strategies yield the same expected value. That is,

$$V_I = V_{II} = V_{III} \tag{2.7}$$

The model, which is represented by Equations (2.1) - (2.7), can be solved for the following ex-post allocations of workers in terms of exogenous variables.[1]

$$L_T = \frac{Q_T(1-\theta)}{W_A(1-\varphi)} - \frac{Q_T(\varphi-\theta)}{W_M(1-\varphi)} \tag{2.8}$$

$$L_A = \frac{L}{1-\theta(1-\frac{W_A}{W_M})} - \frac{E_M W_M}{W_A} - \frac{Q_T}{W_A} \tag{2.9}$$

$$U = L - L_T - L_A - E_M \tag{2.10}$$

Total income in the economy is given by

$$I = Q_T + L_A W_A + E_M W_M \tag{2.11}$$

2.3 Welfare Analysis

I evaluate the welfare effects of a policy of modern sector enlargement (MSENL) and a policy of increasing the efficiency of on-the-job search from the urban informal sector (IEOS) by comparing equilibrium income distributions before and after the application of each policy. MSENL is modeled as an increase in E_M, while IEOS is modeled as an increase in φ.

[1]The derivations can be found in Appendix B.2.

In general, making unambiguous welfare comparisons depends critically on which specific welfare criterion is adopted. Thereom 1, proposed by Atkinson (1970) and later extended by Dasgupta et al. (1973), states that under certain conditions, however, the welfare of one income distribution may be ranked relative to another for a broad range of social welfare functions.

Theorem 1. *Let X and Y be two income distributions with equal means. Let $\mathbb{W}$ denote the class of anonymous, increasing and Schur-concave social welfare functions. Then, X Lorenz dominates Y if and only if $w(X) > w(Y)$ for all $w \in \mathbb{W}$.*

Theorem 1 facilitates the welfare analysis in two ways. First, it reduces an analysis of welfare to one of inequality. If workers derive utility solely from income, which is implied by the search strategy behavior described by Equation (2.7), then an income distribution that Lorenz dominates another with the same mean is not only more equal, but *better* in terms of welfare. Thus, Theorem 1 ensures that the income distribution provides sufficient information to make welfare inferences.

Second, Theorem 1 ensures the robustness of any welfare implications, because the great majority of accepted social welfare functions are included within $\mathbb{W}$. Anonymity simply requires that all workers are treated identically regardless of which particular ones receive how much income. The "increasing" property ensures that social welfare increases whenever one worker's earnings increase, holding other workers earnings constant. Finally, Schur-concavity, - a weaker condition than concavity - ensures that the "transfer principle" of Pigou (1912) and Dalton (1920) is satisfied. That is, a welfare function registers an increase in well-being when income is transferred from a richer to a poorer worker without reversing the ranking of each. I address the prerequisite of Theorem 1 in Proposition 1.

Proposition 1. *MSENL and IEOS do not affect the mean of the income distribution.*

Proof. The model emits explicit equations for labor allocations and earnings. I can therefore assess the impact of MSENL and IEOS by evaluating derivatives with respect to E_M and φ, respectively. Because population is fixed at L, it is sufficient to show that total income, I, is unchanged. It follows from Equation (2.11) that

$$\frac{\partial I}{\partial E_M} = \frac{\partial L_A}{\partial E_M} W_A + W_M \tag{2.12}$$

$$\frac{\partial I}{\partial \varphi} = \frac{\partial L_A}{\partial \varphi} \tag{2.13}$$

because Q_T, W_A and W_M are exogenously fixed. Equation (2.9) implies that $\frac{\partial L_A}{\partial E_M} = -\frac{W_M}{W_A}$ and $\frac{\partial L_A}{\partial \varphi} = 0$. Respectively substituting these expressions into (2.12) and (C.3.1) yields $\frac{\partial I}{\partial E_M} = 0$ and $\frac{\partial I}{\partial \varphi} = 0$ as required. □

Proposition 1 demonstrates that MSENL and IEOS reallocate workers and earnings across sectors in a manner that is neutral in terms of total income, thereby allowing Theorem 1 to be applied. It therefore remains to determine whether the labor market policies yield non-intersecting Lorenz curves.

Proposition 2. *MSENL causes a Lorenz worsening.*

Proof. Workers fall into one of four employment categories. A Lorenz curve therefore consists of four piecewise linear segments, each characterized by the position of three kink points as shown in Figure B.1. Without loss of generality, I normalize $I = 1$ and $L = 1$ so that the coordinates of the kink points are $K_1 = (U, 0)$, $K_2 = (U + L_T, Q_T)$ and $K_3 = (1 - E_M, 1 - W_M \cdot E_M)$. Equations (2.8)-(2.10) imply

$$\frac{\partial U}{\partial E_M} = \frac{W_M}{W_A} - 1 > 0\,, \frac{\partial L_T}{\partial E_M} = 0$$

The increase in unemployment shifts K_1 to the right which also shifts K_2 to the right because L_T is unchanged. The vertical position of K_2 is unaltered because Q_T is exogenously fixed. The increase in E_M directly shifts K_3 down and to the left. The resulting Lorenz curve following MSENL lies partly below and never above the original Lorenz curve as depicted by the dashed red line in Figure B.1. This is a Lorenz worsening. □

[Insert Figure B.1 about here]

Proposition 3. *IEOS causes a Lorenz improvement.*

Proof. Equations (2.8)-(2.10) imply

$$\frac{\partial U}{\partial \varphi} = -\frac{Q_T(1-\theta)}{(1-\varphi)^2}\left[\frac{1}{W_A} - \frac{1}{W_M}\right] < 0 \ , \quad \frac{\partial L_T}{\partial \varphi} = \frac{Q_T(1-\theta)}{(1-\varphi)^2}\left[\frac{1}{W_A} - \frac{1}{W_M}\right] > 0, \quad \frac{\partial L_A}{\partial \varphi} = 0$$

The decrease in unemployment shifts K_1 to the left. Because E_M and L_A are unaffected, $U + L_T = L - E_M - L_A$ is unchanged and therefore K_2 remains in its horizontal position. K_2 also remains in its vertical position because Q_T is exogenously fixed. Fixed levels of E_M and W_M ensure that K_3 is unaltered. The resulting Lorenz curve following IEOS lies partly above and never below the original Lorenz curve as depicted by the dotted green line in Figure B.1. This is a Lorenz improvement. □

Propositions 2 and 3 demonstrate that both policies produce strict Lorenz orderings. In isolation, these results imply that MSENL increases inequality and IEOS decreases inequality. When combined with Theorem 1 and Proposition 1, however, the findings also have normative significance. Theorem 2, which is the main result of this article, follows directly from Theorem 1 and Propositions 1-3.

Theorem 2. *For all anonymous, increasing and Schur-concave social welfare functions, MSENL decreases social welfare and IEOS increases social welfare.*

2.4 Conclusion

Within the context of the generalized Harris-Todaro model proposed by Fields (1989), I demonstrate that both MSENL and IEOS do not alter the mean of the income distribution. I then show that MSENL causes a Lorenz worsening and IEOS causes a Lorenz improvement. These properties allow me to draw robust welfare conclusions by exploiting Atkinson's (1970) classic theorem, which demonstrates that Lorenz orderings coincide with welfare orderings for a very broad class of welfare functions. I conclude that a policy of MSENL therefore reduces social welfare while a policy of IEOS improves social welfare.

This article makes three contributions. First, it extends the work of Fields (2005), who performs welfare economic analyses within the basic HT framework, to the more complex multi-sector labor market model of Fields (1989). Second, it widens the scope of policy analysis to include welfare effects that are robust to all anonymous, increasing and Schur-concave social welfare functions. Third, and relatedly, it provides what is to my knowledge the first direct application of the Atkinson (1970) theorem within a multi-sector labor market model.

CHAPTER 3

LAFFER CURVES IN THE PRESENCE OF INTERNATIONAL MIGRATION

3.1 Introduction

"I am leaving because you believe success, creation, talent, anything different must be sanctioned."

- Gerard Depardieu

The Maastricht Treaty, which removed all legal barriers to migration within the European Union, improved the ability of Europeans to vote with their feet. The emergence of preferential tax schemes for high-skilled foreign workers indicates an increasing recognition of this fact by many European governments (OECD, 2011). However, despite a long standing recognition of the importance of international migration for the design of fiscal policy (Tiebout, 1956; Mirrlees, 1971), there is surprisingly little research examining its implications for the explicit ability of governments to generate tax revenue. This article aims to help fill the gap.

This issue is of particular concern at the moment, with Europe facing unprecedented sovereign debt levels in the aftermath of the global financial crisis. The majority of EU countries remain in violation of the public debt ceiling of 60 percent of GDP and the 3 percent government deficit limit imposed by the Maastricht Treaty, and the Stability and Growth Pact, respectively. In response to this deterioration in their public finances, a number of European countries have adopted austerity packages that feature increases in tax rates (Mendoza et al., 2014), with the intention of raising revenue in order to ease fiscal concerns.

However, increases in tax rates do not always lead to an increase in government revenue. On the contrary, I show that mobile labor within Europe implies that the majority of European countries would be more effective in raising government revenue if they *reduced* tax rates. That is, Europe is currently on the "slippery slope" of the Laffer curve.

In order to show this, I construct a static two country neoclassical model similar to Razin and Sadka (2011) in which the government collects distortionary taxes on labor and capital income, and in which all factors of production are free to move across countries. I demonstrate that international migration increases the elasticity of total labor supply with respect to changes in the after tax wage by inducing cross border movements of workers. This has the effect of shifting the Laffer curve for both labor and capital taxes to the left.

The labor supply elasticity is known to be a crucial determinant of the shape and location of the Laffer curve (Mankiw and Weinzierl, 2006). I show that international migration is quantitatively more important. Specifically, I find that increasing the labor supply elasticity from 0.5 to 1.5 in a closed economy without migration shifts the location of the peak of the labor tax Laffer curve from a labor tax rate of 66% to 39% for the aggregate EU-14 (the EU-15 excluding Luxembourg) economy. Removing restrictions on labor migration, on the other hand, shifts the peak from 66% to 28% while maintaining the labor supply elasticity of 0.5. Similarly, the peak of the capital tax Laffer curve shifts from a capital tax rate of 30% to 14% upon increasing the labor supply elasticity in a closed economy. The revenue maximizing tax rate when labor is internationally mobile is just 4%. Given that the average labor and capital rates are currently 41% and 33% respectively, these estimates imply that the average EU-14 economy is currently situated on the "slippery slope" of both the labor and capital tax Laffer curves. That is, the majority of European countries ought to *reduce* tax rates in order to increase tax revenue.

Methodologically, this article is most closely related to the work of Mankiw and Weinzierl (2006) and Trabandt and Uhlig (2011). Mankiw and Weinzierl (2006) investigate the implications of the neoclassical growth model for dynamic scoring. Like this article, their analysis yields simple formulas to show how much a tax cut is self-financing once dynamic feedback effects are taken into account. Trabandt and Uhlig (2011) extend Mankiw and Weinzierl (2006) to gain quantitative estimates across different countries. Furthermore, like the analysis in this article, they explicitly characterize the shape of the Laffer curves. In particular, they identify the revenue maximizing tax rates as well as the additional revenue to be gained by adopting those tax rates.

Both Mankiw and Weinzierl (2006) and Trabandt and Uhlig (2011), however, follow most of the the large macroeconomic literature on revenue estimation (Ireland, 1994; Schmitt-Grohe and Uribe, 1997; Leeper and Yang, 2008; Holter et al., 2014) by treating countries as isolated economic units, thereby ignoring the potential for the erosion of tax bases induced by factor mobility. Although Mirrlees (1982, p. 319) recognized that "high tax rates encourage emigration" and that "the resulting loss of tax revenue is widely believed to be an important reason for keeping taxes down," to my knowledge there is no explicit research examining the effect of migration on a government's ability to raise tax revenue.

In more recent work, Mendoza et al. (2014, p. 1) rightly point out that "there has been surprisingly little discussion of the constraints imposed on fiscal policy by the fact the eurozone countries are highly integrated." However, their analysis of European Laffer curves considers only capital and goods market integration, while ignoring labor mobility. Nevertheless, their finding that the international mobility of capital allows for a more elastic capital tax base which shifts the Laffer curve to the left is analogous to my result. Traditional closed economy models that restrict the mobility of production factors underestimate the elasticity of tax bases, thereby overestimating the ability of the government to raise tax revenue at relatively high tax rates.

The importance of migration on fiscal policy decisions does, however, have a long history in the optimal taxation literature. Commenting on the migration restrictions imposed in his seminal paper, Mirrlees (1971, p. 176) states that "since the threat of migration is a major influence on...actual tax systems...this is another assumption one would rather not make." He later relaxed this assumption to derive an optimal average tax rate that is inversely proportional to the elasticity of migration (Mirrlees, 1982). Many studies examining optimal tax rates in the presence of migration have followed (Leite-Monteiro, 1997; Simula and Trannoy, 2010; Lehmann et al., 2014).

Finally, this article is also related to a burgeoning empirical literature investigating the effect of taxation on the international mobility of workers (Kleven et al., 2013, 2014) which builds on a larger literature on tax induced mobility across local jurisdictions (Shaw, 1986; Kirchgassner and Pommerehne, 1996; Bakija and Slemrod, 2004; Young and Varner, 2011).

Before proceeding, it is worth pointing out that maximizing tax revenues is distinct from maximizing welfare. This article does not analyze the welfare implications of tax changes, nor does it consider strategic interactions between competing fiscal authorities. The focus is on the impact of international migration on the ability of governments to unilaterally raise tax revenue in the face of unrestricted labor movements - a question of considerable practical interest.

The article proceeds as follows. In section 3.2, I discuss the simple two country static model. In section 3.3, I analyze the consequences of international migration on Laffer Curves within the European Union. I conclude in section 3.4.

3.2 Model

The world consists of a union of states and the rest of the world. Goods and capital move freely both within the union and the rest of the world. Labor, however, may only move freely within the union, which consists of two countries - Home and Foreign. The $\bar{N}$ workers in the union endogenously allocate themselves across countries so that, at any given time, N workers reside in the Home country and $N_* = \bar{N} - N$ reside in the Foreign country. Each country has an independent fiscal authority which raises revenue through distortionary taxation by taxing capital according to the source principle, and labor according to the residency principle. Because each country operates the same production technology, and all workers share the same preferences, I focus the model description below on the Home country. Where necessary, however, I denote Foreign country variables with stars.

Consider a static model in which aggregate production Y is determined according to the following decreasing returns to scale production function[1]

$$Y = \left(K^{\alpha} L^{1-\alpha}\right)^{\chi}, \quad \chi < 1$$

where K is the total amount of capital stock employed in the Home country, $L = Nl$ is the total amount of effective labor input, l represents hours worked per worker, α is the income share of capital, and χ determines the scale of diminishing returns. I assume that these diseconomies of scale are *external* to each perfectly competitive firm, which produces firm level output Y_f according to $Y_f = AK_f^{\alpha} L_f^{1-\alpha}$ where $A = 1/(K^{\alpha} L^{1-\alpha})^{1-\chi}$ is a function of aggregate stocks but is taken as given by firms. Competitive input markets ensure that the pre-tax rate of return on capital r and the wage per unit of effective labor w are equal to their respective marginal products

$$r = \frac{\partial Y_f}{\partial K_f} \quad , \quad w = \frac{\partial Y_f}{\partial L_f} \tag{3.1}$$

The utility function of workers is given by

$$u = c - \frac{l^{1+1/\epsilon}}{1 + 1/\epsilon} \tag{3.2}$$

where c denotes consumption and $\epsilon > 0$ is the labor supply elasticity. The budget constraint of each worker is

$$c = [(1 - I_*)(1 - \tau_L)wl + I_*(1 - \tau_{L*})w_* l_*] + (1 + \bar{r})k \tag{3.3}$$

where k represents individual capital holdings and τ_L is the tax rate on labor in the Home country. The indicator function I_* indicates the residency decision of the worker, and is equal to one when the individual chooses to reside in the Foreign

[1] Proposition 4 in Appendix C.4 demonstrates why the departure from constant returns is necessary when all factors of production are mobile. See Binyamini and Razin (2008) and Rasmussen (2013) for other examples of decreasing returns in the context of migration.

country, in which case she earns an after tax wage of $(1-\tau_{L*})w_*$. The world after tax return on capital $\bar{r}$ is taken as exogenous by the union members and is therefore equivalent across each country due to the free movement of capital.

$$\bar{r} = r(1 - \tau_K) = r_*(1 - \tau_{K*}) \tag{3.4}$$

Individual utility maximization implies that labor supply is determined by

$$l = [w(1 - \tau_L)]^\epsilon \tag{3.5}$$

The indirect utility function of workers residing in the Home country V can therefore be stated as follows

$$V = \frac{1}{1+\epsilon}\left[(1 - \tau_L)w\right]^{1+\epsilon} + (1 + \bar{r})k \tag{3.6}$$

and free migration, which implies that $V = V^*$ implies that after tax real wages must be equalized across countries according to Equation (3.7).

$$(1 - \tau_L)w = (1 - \tau_{L*})w_* \tag{3.7}$$

Finally, total government revenue, R, is the sum of taxes paid on capital and labor income earned by the factors of production that are resident within that country.

$$R = rK\tau_K + wL\tau_L \tag{3.8}$$

3.3 Analysis

In this section, I estimate the impact of changes in capital and labor tax rates on total tax revenue R. Conventional *static* scoring estimates assume that changes in tax rates do not impact national income or other macroeconomic variables. Static estimates are therefore simply equal to the respective tax bases of each tax rate, as demonstrated in Equations (3.9) and (3.10).

$$\left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Static}} = wL \tag{3.9}$$

$$\left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Static}} = rK \tag{3.10}$$

The actual change in tax revenues, however, will differ from these static estimates. Dynamic estimates take into account the effect of the tax change on the tax base. Equations (3.11) and (3.12) demonstrate that the model emits explicit relationships between static and dynamic estimates of the effects of tax changes on government revenue.[2]

$$\left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Dynamic}} = (1 - \Theta_L) \times \left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Static}} \tag{3.11}$$

$$\left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Dynamic}} = (1 - \Theta_K) \times \left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Static}} \tag{3.12}$$

where

$$\Theta_L = \frac{\chi(\alpha\tau_K + (1-\alpha)\tau_L)}{(1 - \chi\alpha + \epsilon(1-\chi))(1-\tau_L)}\left(\epsilon + \frac{1-\chi\alpha}{1-\chi}\frac{N_*}{\bar{N}}\right) \tag{3.13}$$

$$\Theta_K = \frac{\chi(\alpha\tau_K + (1-\alpha)\tau_L)}{(1 - \chi\alpha + \epsilon(1-\chi))(1-\tau_K)}\left(1 + \epsilon + \frac{(1-\alpha)\chi}{1-\chi}\frac{N_*}{\bar{N}}\right) \tag{3.14}$$

Θ_L and Θ_K represent the respective percentages of a labor and capital tax cut that pay for themselves. These terms are always positive, which means that the dynamic feedback effects ensure that a tax cut always stimulates economic activity in such a way as to reduce the full impact on government revenue that is implied by static estimates. Each term is increasing in both the elasticity of labor

[2]Derivations of these equations can be found in Appendix C.3.

ϵ, as well as the relative population size of the Foreign country $\frac{N_*}{\bar{N}}$. A more elastic intensive labor supply implies that labor responds more strongly to tax cuts, thereby stimulating a higher level of the labor income tax base. This occurs for reductions in the labor tax rate, which directly increases after tax wages, but also for reductions in capital tax rates, which indirectly increases after tax wages via an increase in the aggregate capital stock. See Mankiw and Weinzierl (2006) for a discussion of this well-understood point.[3] A main contribution of this article is to show that international migration flows further strengthens this channel. As $\frac{N^*}{\bar{N}}$ increases (a closed economy is represented by $\frac{N_*}{\bar{N}} = 0$), there is a greater potential pool of foreign labor that is attracted to the Home country by a tax cut. The domestic labor supply therefore increases, which further softens the effect of a tax cut on government revenues. International migration effectively introduces an extensive margin of labor supply, thereby increasing the elasticity of total labor supply with respect to changes in tax rates. Binyamini and Razin (2008) make this point when demonstrating that international migration induces a flatter Phillips Curve.

The values of six parameters (α, χ, ϵ, τ_K, τ_L, $\frac{N_*}{\bar{N}}$) are required to understand the magnitude of these feedback effects. Following Trabandt and Uhlig (2011), I calibrate the tax rates to match the average effective tax rates between 1995 and 2007 for 14 of the EU-15 countries (excluding Luxembourg) as well as the aggregate EU-14 economy, which are presented in Table C.1. Average effective labor tax rates varied from 27% in Ireland to 56% in Sweden with an EU-14 average of 41%. Average effective capital tax rates, on the other hand, were lower on average

[3] Equations (3.11) and (3.12) coincide with Equations (6) and (5) of Mankiw and Weinzierl (2006) under equivalent assumptions ($\chi = 1$, $\epsilon = 0$, $\frac{N^*}{\bar{N}} = 0$). Note that constant returns to scale ($\chi = 1$) is appropriate in this case without migration. Using their calibration under a basic closed-economy Ramsey model ($\alpha = 1/3$, $\tau_K = \tau_L = 1/4$) yields identical results ($\frac{\partial R}{\partial \tau_K}|_{\text{Dynamic}} = \frac{1}{2}\frac{\partial R}{\partial \tau_K}|_{\text{Static}}$).

at 33% but varying from 16% in Greece to 51% in Denmark.

[Insert Table C.1 about here]

I also adopt the capital share of production of $\alpha = 0.38$ found in Trabandt and Uhlig (2011). The literature provides little guidance for the degree of diminishing returns χ. In order to calibrate this parameter, I take a recent empirical finding by Kleven et al. (2014), who exploited a natural experiment created by a preferential foreigner tax scheme in Denmark to estimate a strikingly large elasticity of migration with respect to the net-of-tax rate of around 1.5. In the current model, this implies that

$$\frac{\alpha\chi}{1-\chi}\frac{N_*}{\bar{N}} \approx 1.5$$

which, assuming the two countries are of equal size ($\frac{N_*}{\bar{N}} = 0.5$), yields a value of $\chi = 0.9$.[4] The remaining parameter is the elasticity of labor supply ϵ. This value is not only of central importance for the shape of the Laffer curve (Trabandt and Uhlig, 2011), it is also the subject of a well known and ongoing academic debate.[5] Rather than taking a stand on this debate, I perform all calculations under two different labor supply elasticity assumptions. I choose the first ($\epsilon = 0.5$) to represent the building consensus on "micro estimates" (Bianchi et al., 2001; Pistaferri, 2003; Chetty et al., 2011) and the second ($\epsilon = 1.5$) to represent the mid point for "macro estimates" (Prescott, 2004; Kimball and Shapiro, 2008).

Table C.2 presents the resulting self financing percentages for each country under both labor supply elasticity assumptions. In order to capture the effect of

[4]In their investigation of European Laffer curves, Mendoza et al. (2014) use similar logic to calibrate an investment-adjustment-cost parameter by exploiting empirical estimates of the elasticity of the capital tax base to changes in capital tax rates.

[5]See Ljungqvist and Sargent (2011) and Chetty et al. (2011) for a recent discussion.

international migration on these estimates, I also present the results under the assumption that international migration is completely restricted, in which case population is fixed ($\frac{N_*}{\bar{N}} = 0$), and under the assumption of free migration, in which case the population is endogenously determined. Column 1 of Table C.2 shows that labor tax cuts are at least partially self financing in all countries when labor supply is relatively inelastic ($\epsilon = 0.5$) and migration is restricted. For the aggregate EU-14 economy, the growth stimulated by a labor tax cut pays for 41% of the static revenue loss, which means that static estimates overstate the reduction in tax revenue by 59%. Shifting to a more elastic labor supply ($\epsilon = 1.5$), Column 2 shows that the self financing percentages all increase, as predicted by inspection of the expressions in Equation (3.13) and (3.14), and in some cases become more than fully self-financing. The EU-14, for example, has a self financing percentage of 107%. When the self-financing percentages are greater than 100, tax cuts sufficiently stimulate activity so as to more than eliminate the static effect of a tax cut. This corresponds to the downward sloping portion of the Laffer curve, which will be discussed in more detail in Section 3.3.1. Columns 3 and 4 show that when migration is unrestricted, labor tax cuts are more than fully self-financed for all EU-14 countries. A reduction in labor taxes induces a sufficient amount of immigration to actually increase government revenue, even when labor supply is relatively inelastic ($\epsilon = 0.5$).

[Insert Table C.2 about here]

Column 5 in Table C.2 shows that capital tax cuts would more than pay for themselves in the majority of EU-14 countries even when migration is restricted and labor supply is relatively inelastic. Under these assumptions, a capital tax cut in the aggregate EU-14 economy actually increases revenue by 8% of the decline in revenue predicted by static estimates. Again, when labor is internationally mobile, these figures increase, as the capital inflow induced by capital tax cuts increases wages, thereby attracting foreign workers and raising the total supply of labor.

The main point here is clear. Allowing for migration substantially increases the scope for self financing tax cuts under current tax regimes. These self financing percentages provide information regarding the slopes of their respective Laffer curves at current tax rates. Therefore, free labor movement within the European union implies that all European economies are on the downward sloping portion of their respective Laffer curves. In the next sections I analyze these Laffer curves in more detail.

3.3.1 Labor Tax Laffer Curve

The Laffer curve for labor income taxation in the aggregate EU-14 economy is shown in Figure C.1. To obtain this plot, I varied labor taxes between 0% and 100% while holding all parameters and the capital tax rate constant at the EU-14 value of $\tau_k = 33\%$. For comparison purposes, total tax revenue is normalized to 100 at the calibrated labor tax rate of $\tau_L = 41\%$, as indicated by the solid vertical line. Comparing first the solid and dashed red lines, which trace out the Laffer curves under the assumption that there is no migration ($\frac{N_*}{\bar{N}} = 0$), reveals that an increase in the elasticity of labor supply shifts the peak of the Laffer curve to the left. When labor supply is more responsive to changes in the after tax wage, raising revenue is more effective at lower tax rates. Indeed, the economy shifts from the upward sloping portion of the Laffer curve to the downward sloping portion when ϵ increases from 0.5 to 1.5, which is consistent with the self financing percentages shifting from below 100 (Column 1) to above 100 (Column 2) in Table C.2.

[Insert Figure C.1 and Table C.3 about here]

Table C.3, which provides the results for the location and height of the Laffer curve peak, confirms that the revenue maximizing tax rate in the EU-14 under the $\epsilon = 0.5$ case is 66% (Column 2), which falls to 39% under the more elastic ($\epsilon = 1.5$) case (Column 3). The government could increase total revenue by 13% under the $\epsilon = 0.5$ case (Column 6) and by a negligible amount under the $\epsilon = 1.5$ case (Column 7). A similar story holds when comparing the solid and dashed black lines in Figure C.1, which trace out the Laffer curves under the assumption that labor is internationally mobile. According to Table C.3, when migration restrictions are relaxed, the revenue maximizing labor tax rate falls from 28% (Column 4) to 24% (Column 5) when ϵ is increased.

By comparing the solid red and black curves, we see that allowing international migration has a qualitatively similar effect to increasing the labor supply elasticity, which is to shift the peak of the Laffer curve to the left. These visual observations are formalized in Proposition 5 in Appendix C.4, which states that the peak of the Laffer curve always shifts to the left when migration restrictions are relaxed and when labor supply elasticities increase, provided the Laffer curve peak is interior. Table C.3 shows that in the $\epsilon = 0.5$ case, the revenue maximizing labor tax rate falls from 66% (Column 2) to 28% (Column 4) once migration restrictions are relaxed. Given that the actual tax rate is 41%, this also has the effect of shifting the economy from the upward sloping portion of the Laffer curve to the downward sloping portion.

Looking down Table C.3 reveals that all EU-14 countries apart from Ireland and Portugal are also on the downward sloping portion of the labour tax Laffer curve when labor is internationally mobile. This means that for most EU-14 countries, labor tax cuts would more than pay for themselves. Comparing the values in Column 2 with those in Columns 3 and 4 reveals that for all countries, the presence of international migration is quantitatively more important than the labor supply elasticity in determining the location of the Laffer curve peak, at least within the range of elasticities considered here.

The amount of additional tax revenue that can be gained by switching to the revenue maximizing tax rate (the peak of the Laffer curve) differs strikingly across countries. Under the $\epsilon = 0.5$ case with no migration restrictions, for example, Denmark stands to gain a 173% increase (Column 8) in tax revenues by lowering its labor tax rate from 47% (Column 1) to 18% (Column 2). Greece, however, only stands to gain a 4% increase in income after lowering its labor income tax rate from 41% to 35%. See Appendix C.5 for a graphical representation of the information provided for individual countries in Table C.3.

3.3.2 Capital Tax Laffer Curve

The Laffer curve for capital income taxation in the aggregate EU-14 economy is presented in Figure C.2. I obtain this plot in a similar manner to Figure C.1, but this time varying the capital tax rate while holding the labor tax rate constant at

$\tau_L = 41\%$. Like the labor tax Laffer curves, removing restrictions on migration and increasing the labor supply elasticities shifts the peak of the Laffer curve leftward, which is also demonstrated formally in Proposition 5. The EU-14 is situated on the downward sloping portion of the capital tax Laffer curve under all migration and labor supply elasticity assumptions. Table C.4 reveals that this is the case for many of the individual countries as well. When there are no migration restrictions, every country except for Ireland is on the downward sloping portion of the Laffer curve.

[Insert Figure C.2 and Table C.4 about here]

When comparing the revenue maximizing tax rates across the labor and capital tax Laffer curves (Tables C.3 and C.4), the peaks of the capital Laffer curves are always located to the left of their labor counterparts. Indeed, Column 5 of Table C.4 reveals that just 4 of the 14 individual countries maximize tax revenue at a non zero value of τ_K when labor is mobile and relatively more elastic ($\epsilon = 1.5$). Comparing Column 2 with Columns 3 and 4 reveals that international migration is also quantitatively more important that the labor supply elasticity in determining the location of the capital tax Laffer curve. Finally, comparing Columns 8 and 9 across Tables C.3 and C.4 reveals that reductions in capital taxes provide more scope than reductions in labor taxes to raise revenue. For example, when labor is internationally mobile and inelastic ($\epsilon = 0.5$) (Column 8), the EU-14 can gain an additional 30% of revenue through capital tax reductions whereas it can only gain an additional 22% through labor tax reductions. See Appendix C.6 for a graphical representation of the information provided for individual countries in Table C.3.

3.4 Conclusion

This article is motivated by two central characteristics of the modern European economy. The first is the unprecedented levels of sovereign debt, which have prioritized the need for fiscal authorities to raise tax revenue. The second is the freedom of labor movement enabled by the Maastricht Treaty. I argue that the latter characteristic cannot be ignored when considering solutions to the first.

Specifically, I show within a static two country model that international migration is quantitatively more important than labor elasticities in determining the position of the Laffer curve. Unrestricted migration increases the elasticity of total labor supply with respect to changes in the after tax wage by inducing cross border movements of workers. The revenue maximizing tax rates for both labor and capital are therefore reduced.

A simple calibration reveals that free labor mobility in Europe implies that almost every economy in the EU-14 is located on the "slippery slope" of the labor and capital tax Laffer curve. Thus, tax cuts are currently a viable avenue to raise tax revenue in Europe.

CHAPTER 4

THE EFFECT OF TAX EXPENDITURES ON AUTOMATIC STABILIZERS: METHODS AND EVIDENCE

4.1 Introduction

The federal government "spends" through the tax code by exempting certain economic activities from taxation. Research has examined how these "tax expenditures" affect individual behavior (Hilber and Turner, 2014) and how the benefits of such tax expenditures are unequally distributed across income groups (Burman et al., 2008). We broaden these insights by examining tax expenditures within the wider context of the federal tax system. In particular, we investigate how tax expenditures affect the ability of the tax system to stabilize household disposable income and consumption.

The income tax system reduces fluctuations in disposable income by partially absorbing shocks to market income. Tax expenditures may distort this ability of the tax system to function as an automatic stabilizer. In this article, we measure these distortions. We propose a method to estimate the effect of a tax expenditure on the ability of the tax system to act as an automatic stabilizer. In developing this method, we exploit underlying theoretical links we identify between measures of the automatic stabilizing power of a tax system, the size of tax expenditures, and effective marginal tax rates (EMTR).

We measure the automatic stabilization of disposable income using the Normalized Tax Change (NTC) (Auerbach and Feenberg, 2000), which captures how much aggregate tax revenue changes in response to a change in aggregate market income (Slitor, 1948). To measure how a tax expenditure affects the automatic stabilization of disposable income, we estimate the change in the NTC induced by the removal of the provision. This change, which we call the NTC Shifter (NTCS), measures the destabilizing effect of a tax expenditure on disposable income. We show that the NTCS can be interpreted as (1) the extra proportion of a fluctuation in market income that would be absorbed by the tax system in the absence of the tax expenditure, (2) the sensitivity of the tax expenditure to income changes, or (3) the sensitivity of the EMTR to the removal of the tax expenditure.

Automatic stabilizers deal with business cycle fluctuations, which are inherently transitory. Because consumption of rational agents depends on permanent—not transitory—income, the effect of tax expenditures on disposable income stabilization must be translated into demand stabilization by adjusting for each household's marginal propensity to consume (MPC). To estimate demand stabilization, we adopt the standard assumption that Hand-to-Mouth (HtM) households have a MPC equal to one, while all other households have a zero MPC (Auerbach and Feenberg, 2000; Dolls et al., 2012). The MPC Adjusted NTC (ANTC) measures how much aggregate tax revenue *that would have otherwise been spent* changes in response to a change in aggregate market income.

We define our empirical measure of the effect of a tax expenditure on automatic stabilization as the change in the ANTC induced by the removal of the provision. This measure, which we call the ANTC Shifter (ANTCS), estimates the extra amount of consumption, as a proportion of a fluctuation in market income, that the tax system would absorb in the absence of the tax provision.

Using microdata from the Survey of Consumer Finances (SCF) from 1988 to 2009, we find evidence that two of the largest tax expenditures—the Mortgage

Interest Deduction (MID) and the Charitable Contributions Deduction (CCD)—alter the federal tax system's role as an automatic stabilizer. The MID and CCD decreased the ability of the tax system to absorb fluctuations in aggregate consumption by an average of 4.92% and 4.20%, respectively. These estimates tell us how much the tax provisions change the relative ability of the tax system to absorb consumption.

In order to interpret the findings in terms of how a tax provision changes the sensitivity of consumption to income fluctuations, which is the policy relevant measure that can be compared to equivalent measurements from the consumption response literature (Kniesner and Ziliak, 2002), we must normalize the ANTCS by the baseline sensitivity of consumption to income fluctuations (Kingi and Rozema, 2015). This normalized measure estimates the increase in the reaction of consumption to income changes caused by the tax provision. We find that the MID and CCD increased the sensitivity of consumption to income fluctuations from a baseline of 0.14 by 1.13% and 0.97%, respectively. A back of the envelope calculation suggests that, in light of a 3% recession, the removal of the MID and CCD would have been to stabilize annual consumption by an average of $3.5 and $3.1 billion (in 2012 dollars), respectively. The MID and CCD substantially decrease the tax system's ability to stabilize demand.

The attractiveness of a tax expenditure, both politically and as a means to increase social welfare, is rarely analyzed in light of its relationship with the general stabilizing effect of the federal tax system (Listokin, 2012). It is our view that the assessment of the desirability of a tax expenditure ought to take this relationship into account. An important part of this assessment lies in knowing the magnitude of the change in automatic stabilization caused by a tax expenditure. Our paper makes a first attempt at measuring this.

We make two contributions. First, we consolidate concepts of automatic stabilizers, effective marginal tax rates, and tax expenditures into a single theoretical framework. Our main contribution is to exploit this framework to propose and implement a method for estimating the effect of a tax expenditure on the ability of the tax system to act as an automatic stabilizer. In addition to microsimulation techniques from the automatic stabilization literature (Auerbach and Feenberg, 2000; Dolls et al., 2012), our empirical approach incorporates techniques used to estimate the size of tax expenditures (Poterba and Sinai, 2011) and the methods used to estimate changes in the EMTR (Barro and Sahasakul, 1983; Saez, 2004; Mertens and Ravn, 2013). We show that changes in the NTC can be explicitly expressed in terms of tax expenditures and of changes in the EMTR. These links justify our empirical method for estimating the destabilizing effect of a tax expenditure.

The paper proceeds as follows. Section 4.2 sets out the theoretical framework behind our analysis. We develop our empirical methodology in Section 4.3. In Section 4.3.1, we propose our empirical measure of the effect of a tax expenditure on the ability of the tax system to act as an automatic stabilizer and discuss the complications that arise in estimating this measure. In Section 4.3.2, we derive the connection between the NTC and the EMTR, and introduce a new formula that encompasses both of these concepts. Section 4.3.3 demonstrates the key concepts of how tax expenditures can influence automatic stabilizers through simple numerical examples. Section 4.4 describes the data and the channels through which tax expenditures can influence stabilization. Section 4.5 presents our results and Section 4.6 concludes.

4.2 Theoretical Framework

4.2.1 Literature Review

Our research lies at the intersection of the literatures on automatic stabilizers and tax expenditures. The income tax system functions as an automatic stabilizer by partially absorbing shocks to market income. Theoretical work on automatic stabilizers began with Musgrave and Miller (1948) and Slitor (1948). Empirical work that measures the size of automatic stabilizers can be divided into micro and macro studies. Our work is closely related to micro studies. These studies apply microsimulation techniques to overcome the main limitation of endogenous aggregate measures of stabilization used in macro studies (Auerbach and Feenberg, 2000; Auerbach, 2009; Dolls et al., 2012), such as the ratio of tax revenue and GDP (International Monetary Fund, 2009), the cyclical elasticity of tax system components with respect to income (van den Noord, 2000; Fatas and Mihov, 2012), and the relationship between government size and output volatility (Gali, 1994; Fatas and Mihov, 2001). Unlike macro approaches using these aggregate-level measures, microsimulation is able to isolate the effects of *automatic* stabilizers from behavioral and general equilibrium effects.

The tax system functions as an automatic stabilizer through at least three channels. First, workers are incentivized to substitute work effort away from booms and into recessions when faced with tax rates that rise in expansionary periods and fall in recessionary periods (Christiano, 1984). Second, if low income households have higher propensities to spend than high income households, redistribution from high to low-income households means that aggregate consumption will rise with redistribution during recessions (Blinder, 1975). Finally, the tax system absorbs fluctuations in market income directly.

We focus on the latter aspect of automatic stabilizers. To do this, we use the concept of a tax system's "built-in flexibility" introduced by Slitor (1948), which says that an income tax system dampens the variability of disposable income and therefore provides insurance against market income volatility (Musgrave and Miller, 1948; Brown, 1955; Brown and Kruizenga, 1959; Cohen, 1959; Pechman, 1973). Auerbach and Feenberg (2000) proposed a microsimulation strategy to estimate built-in flexibility. To construct an empirical measure of built-in flexibility, Auerbach and Feenberg (2000) simulate a 1% change in aggregate income spread neutrally across the population, and estimate tax liability for each tax filer before and after the hypothetical income increase. Auerbach and Feenberg (2000) measure built-in flexibility by estimating the Normalized Tax Change (NTC) according to Equation (4.1).

$$\mathrm{NTC} = \frac{\sum_i \left(\hat{T}_i - T_i\right)}{\sum_i \left(\hat{Y}_i - Y_i\right)} \tag{4.1}$$

where $\hat{T}_i$ is the amount of tax paid by tax filer i after the hypothetical increase in income from Y_i to $\hat{Y}_i$ and T_i was the actual amount of tax paid by tax filer i. The NTC measures the degree to which total tax revenue fluctuates with income.

4.2.2 MPC Adjustment

In order for aggregate demand to be stabilized, the cushioning effect of taxes on disposable income must be translated into a cushioning effect on household consumption, the primary component of aggregate demand. A high reaction of consumption to transitory changes in current disposable income is inconsistent with rational, forward-looking behavior which implies that current demand should depend on some permanent income concept (Auerbach and Feenberg, 2000). In other words, without HtM households with nonzero MPCs, automatic stabilizers would not impact current demand.

To analyze demand stabilization, we adopt the approach of Auerbach and Feenberg (2000) and Dolls et al. (2012) who assume that HtM households fully adjust consumption after changes in disposable income (MPC = 1) while non-HtM households do not adjust consumption at all (MPC = 0). The MPC Adjusted NTC (ANTC) is estimated according to Equation (4.2).

$$\text{ANTC} = \frac{\sum_{i \in \text{HtM}} \left(\hat{T}_i - T_i \right)}{\sum_i \left(\hat{Y}_i - Y_i \right)} \tag{4.2}$$

where HtM is the subset of HtM households. The ANTC measures the change in aggregate taxes *that would have otherwise been spent* in response to, and as a proportion of, changes in market income.

4.3 Empirical Methodology

4.3.1 Measuring the Stabilizing Effect of a Tax Expenditure

We estimate the effect of tax expenditure X on the tax system's ability to stabilize disposable income and consumption by estimating its impact on the NTC and ANTC, respectively. Specifically, for tax expenditure X we define the NTC Shifter (NTCS) according to Equation (4.3) and the ANTC Shifter (ANTCS) according to

Equation (4.4).

$$\text{NTCS}_X = \tilde{\text{NTC}}_{X=0} - \text{NTC} \tag{4.3}$$

$$\text{ANTCS}_X = \tilde{\text{ANTC}}_{X=0} - \text{ANTC} \tag{4.4}$$

where $\tilde{\text{NTC}}_{X=0}$ and $\tilde{\text{ANTC}}_{X=0}$ are the estimated NTC and ANTC in a counterfactual world without tax provision X and with tax credits held constant, respectively. The value of NTCS_X gives the extra proportion of a fluctuation in market income that would be absorbed by the tax system in the absence of tax provision X. The value of ANTCS_X gives the extra amount of consumption, as a proportion of a fluctuation in market income, that the tax system would have absorbed in the absence of tax provision X.

It is worth emphasizing what exactly our estimators capture and how the estimates should be interpreted. The microsimulation used to derive the estimators is designed to assess the sensitivity of consumption to *potential* changes in income (Auerbach and Feenberg, 2000), which, importantly, is precisely what automatic stabilizers deal with.

The main complication that arises in this exercise lies within the assumptions made regarding the counterfactual world in which the tax provision no longer exists. This complication is exactly the well-known complication faced when attempting to estimate tax expenditures (Burman, 2003; Altshuler and Dietz, 2011; Poterba, 2011), as we will show below. We therefore briefly discuss the complication that arises within our method and how we address it in the more familiar setting of how it relates to tax expenditure estimation.

Unlike direct expenditures, tax expenditures cannot be measured using standard accounting methods. Estimating the expenditure from a tax provision instead amounts to estimating the change in federal income tax revenue caused by the hypothetical elimination of a provision in the tax code. The complication in estimating tax expenditures is that the estimates are "static," meaning the exercise assumes that the hypothetical elimination of the tax provision does not influence economic behavior. On the one hand, this is a strong assumption, given that many tax expenditures are precisely designed to alter economic behavior. MID tax expenditure estimates are likely to differ from the amount of revenue that would be gained by eliminating the MID provision (Burman et al., 2008). A substantial literature examines changes in portfolio adjustments that are likely to result from the elimination of the MID (Poterba, 1984; Berkovec and Fullerton, 1992; Jones, 1995; Follain and Melamed, 1998; Dunsky and Follain, 2000; Amromin et al., 2007; Gale et al., 2007; Gervais and Pandey, 2008; Poterba and Sinai, 2008). Poterba and Sinai (2011) estimate that repealing the MID in 2003 would have raised income tax revenues by $72.4 billion in the absence of any household portfolio adjustments, but by $58.5 billion if homeowners drew down financial assets to pay down their mortgage debt.

On the other hand, the alternative assumption of optimal household portfolio reallocation that is required to overcome the limitations of the static estimates is perhaps an even stronger assumption. Like Poterba and Sinai (2011), we find that many households could reduce their tax burden by modifying their asset portfolio, implying that households are not optimizing. Rather than taking a stand on issues of asset portfolio allocation, we simply follow the tax expenditure literature and use static estimates (Burman, 2003; Altshuler and Dietz, 2011; Poterba, 2011).

In the case of the CCD, however, the static assumption has little to no effect on our estimator for stability. This is because charitable giving decisions are expenditure decisions rather than asset allocation decisions and therefore any change in behavior induced by removing the CCD is unlikely to alter personal income. In other words, the removal of the CCD simply makes the consumption good of charitable giving more expensive.

With this complication in mind, consider the procedure for estimating tax expenditures. It consists of running tax filers through a tax calculator under the baseline normal tax structure with and without the tax provision and comparing tax revenues. More formally, the tax expenditure of tax provision X, E_X, is estimated according to Equation (4.5).

$$E_X = \sum_i (T_i^{X=0} - T_i) \tag{4.5}$$

where $T_i^{X=0}$ is the tax liability of tax filer i in the counterfactual world without tax provision X, and T_i is the actual amount of tax liability for tax filer i.

With this definition in hand, we can be more explicit about the relationship between the NTCS and tax expenditures. The NTCS can be expressed as a function of two types of tax expenditures according to Equation (4.6).

$$\text{NTCS}_X = \frac{\hat{E}_X - E_X}{\sum_i \left(\hat{Y}_i - Y_i\right)} \tag{4.6}$$

where $\hat{E}_X$ is the estimated tax expenditure on provision X in a counterfactual scenario with a 1% increase in income for each tax filer and with tax credits held constant. Equation (4.6) demonstrates that a tax expenditure that is highly sensitive to changes in income has a larger effect on stabilization. Our measure can therefore be alternatively interpreted as the sensitivity of tax expenditures to income changes.

In the next section, we set forth a general concept of the economy-wide marginal tax rate, and show how the NTCS can also be interpreted as the sensitivity of the EMTR to the removal of the tax expenditure.

4.3.2 Weighted Average Marginal Tax Rates

Slitor (1948) noted that built-in flexibility (the NTC) is related to the concept of EMTR, which is now used in the macroeconomics literature on the response of aggregate economic activity to changes in marginal tax rates (Barro and Sahasakul, 1983; Saez, 2004; Mertens and Ravn, 2013). To our knowledge, the mathematical relationship between the NTC and the EMTR has not been formally articulated. Equation (4.7) lays out a concept we refer to as the Weighted Average Marginal Tax Rate (WAMTR), which embeds the NTC and EMTR as special cases.

$$\text{WAMTR} = \sum_i \omega_i \left(\frac{\hat{T}_i - T_i}{\Delta_i} \right) \tag{4.7}$$

where $\hat{T}_i$ is the amount of tax paid by tax filer i after a hypothetical increase in income by Δ_i, and ω_i is the weight attributed to tax filer i. The difference between the NTC and the EMTR amounts to differences in the assumed size of the income change Δ_i when numerically constructing the marginal tax rates of each tax filer, where both use income weights ($\omega_i = \frac{Y_i}{\sum_i Y_i}$). The NTC is estimated using a 1% change in income ($\Delta_i = 0.01Y_i$); the EMTR is estimated using a marginal change in income ($\Delta_i = \$1$).

The exercise of estimating the NTCS and ANTCS is therefore very similar to estimating changes in the EMTR common in the business cycle literature (Barro and Sahasakul, 1983). Rather than measuring the effect of marginal income changes on a version of the WAMTR as in the macro literature (specifically, where the

WAMTR is the EMTR), we measure the effect of whole tax provisions on a version of the WAMTR (specifically, where the WAMTR is the NTC). The NTCS can therefore be interpreted as the sensitivity of the WAMTR to the removal of the tax provision.

Before we turn to the empirical section, we present simple numerical examples to illustrate the economic intuition of how tax expenditures can impact automatic stabilizers.

4.3.3 Numerical Examples

All the examples we present feature an economy with two tax brackets and two tax filers. The tax system is characterized by marginal tax rates of 10% and 20% with an income threshold of \$10,000. We denote the gross income of tax filer 1 and 2 by Y_1 and Y_2, respectively. Unless stated otherwise, we follow the notation in the previous sections.

Example 3 (Base Case)**.** $Y_1 = \$8,000$, $Y_2 = \$12,000$

$$T_1 = \$8,000 \times 0.10 = \$800, \quad \hat{T}_1 = \$8,000 \times 1.01 \times 0.10 = \$808$$

$$T_2 = \$10,000 \times 0.10 + (\$12,000 - \$10,000) \times 0.20 = \$1,400$$

$$\hat{T}_2 = \$10,000 \times 0.10 + (\$12,000 \times 1.01 - \$10,000) \times 0.20 = \$1,424$$

$$\text{NTC} = \frac{(\$808 - \$800) + (\$1,424 - \$1,400)}{(\$8,080 - \$8,000) + (\$12,120 - \$12,000)} = 0.16$$

$$\text{EMTR} = 0.1 \times \frac{\$8,000}{\$20,000} + 0.2 \times \frac{\$12,000}{\$20,000} = 0.16$$

Example 3 first outlines the calculation of tax liabilities before (T_i) and after ($\hat{T}_i$) the hypothetical 1% increase in income. Using these tax liabilities, we calculate the

NTC using Equation (4.1) and the EMTR by summing over the income-weighted marginal tax rates.

In this example, the NTC and the EMTR coincide because the 1% income increase used to calculate the NTC does not push tax filer 1 into a higher tax bracket. Therefore, the relevant increase in tax revenue as a percent of income coincides with the marginal tax rates faced by each tax filer. In the next example, we allow for a \$1,000 lump sum deduction from taxable income.

Example 4 (Tax Deduction)**.** $Y_1 = \$8,000$, $Y_2 = \$12,000$, lump-sum deduction = $\$1,000$

$$
\begin{aligned}
T_1 = \$700, \quad \hat{T}_1 = \$708, \quad T_2 = \$1,200, \quad \hat{T}_2 = \$1,224 \\
\text{NTC} = 0.16, \quad \text{EMTR} = 0.16 \\
T_1^{X=0} = \$800, \quad \hat{T}_1^{X=0} = \$808, \quad T_2^{X=0} = \$1,400, \quad \hat{T}_2^{X=0} = \$1,424 \\
E = (\$800 - \$700) + (\$1,400 - \$1,200) = \$300 \\
\hat{E} = (\$808 - \$708) + (\$1,424 - \$1,224) = \$300
\end{aligned}
$$

Example 4 shows that this tax deduction has no effect on the NTC. This surprising result is a consequence of the fact that the deduction in this example does not depend on income and is not sufficiently large as to induce the movement of tax filers across tax brackets.

Using Equation (4.5) to estimate tax expenditures, we subtract the actual tax revenue raised with the hypothetical amount of taxes raised in a world without the deduction to calculate $E = \$300$. Repeating this exercise under the counterfactual scenario of a 1% increase in income ($\hat{E}$), tax expenditures do not change. This is consistent with Equation (4.6) because an unchanged level of tax expenditures implies an unchanged value of the NTC. In the next two examples, we relax the properties that the tax deduction does not induce bracket shifting (Example 5) and that it does not depend on income (Example 6).

Example 5 (Bracket Shifting Deduction). $Y_1 = \$8,000$, $Y_2 = \$12,000$, lump-sum deduction = $\$3,000$

$$T_1 = \$500, \quad \hat{T}_1 = \$508, \quad T_2 = \$900, \quad \hat{T}_2 = \$912$$

$$\text{NTC} = 0.10, \quad \text{EMTR} = 0.10, \quad E = 800, \quad \hat{E} = 812$$

Example 5 demonstrates that the NTC is reduced when a tax deduction allows tax filer 2 to occupy the lower tax bracket. The impact of tax deductions on the stabilizing ability of the tax system depends on the extent to which the deductions induce "bracket shift." Bracket shifting depends on the size of the tax deduction, the number of tax brackets, and the extent to which tax filers are distributed closely to the tax bracket thresholds. Specifically, more bracket shifting occurs with larger tax deductions, more tax brackets, and more tax filers clustered around tax bracket thresholds.

Moving our attention toward tax expenditure estimation, we observe that a tax regime with a larger deduction will have higher tax expenditures. Furthermore, the tax expenditure in the counterfactual scenario with a 1% increase in income, $\hat{E}$, is now larger because tax filer 2 would witness a higher marginal tax rate in the world without the tax expenditure. We can also confirm the important relationship in Equation (4.6) which shows that the value of the NTCS = (0.16−0.10) = 0.06 can be expressed in terms of tax expenditure estimates:

$$\text{NTCS} = \frac{\$812 - \$800}{(\$8,080 - \$8,000) + (\$12,120 - \$12,000)} = 0.06$$

In the next example, we consider the situation where the deduction is dependent on income. In particular, we assume that the deduction is a fixed percentage of income so that any change in income causes a proportional change in the deduction.

Example 6 (Income-Dependent Tax Deduction)**.** $Y_1 = \$8,000$, $Y_2 = \$12,000$, deduction = $12.5\% \times Y_i$

$$T_1 = \$700, \quad \hat{T}_1 = \$707, \quad T_2 = \$1,100, \quad \hat{T}_2 = \$1,121$$

$$\text{NTC} = 0.14, \quad \text{EMTR} = 0.16, \quad E = \$300, \quad \hat{E} = \$303$$

Example 6 demonstrates that a tax deduction which is an increasing function of income reduces the NTC, even without bracket shifting. The tax system is unable to absorb as large a proportion of income when income is increased, because that income increase is accompanied by an increase in the tax deduction.

We next consider the case with no explicit tax deduction, but where tax filer 1 is sufficiently close to the income threshold that a 1% income increase changes her tax bracket.

Example 7 (Bracket Creep)**.** $Y_1 = \$9,950$, $Y_2 = \$12,000$

$$T_1 = \$995, \quad \hat{T}_1 = \$1010, \quad T_2 = \$1,400, \quad \hat{T}_2 = \$1,424$$

$$\text{NTC} = 0.178, \quad \text{EMTR} = 0.155$$

Example 7, when compared to Example 3, demonstrates that the NTC increases when tax filer 1 is sufficiently close to the income tax threshold that a 1% increase in income triggers a change in her marginal tax rate. The economy is better able to absorb fluctuations in income when those fluctuations induce "bracket creep." Because part of the incremental income is taxed at a higher rate, bracket creep diminishes the impact of the income change on disposable income. This occurs despite the fall in the EMTR, which is a result of a larger share of the economy's income being held by tax filer 1 who faces a lower marginal tax rate. The stabilizing effect of bracket creep resulting from an increase in income has the potential to offset the destabilizing effect of bracket shifting induced by tax deductions. Finally, we demonstrate the properties of the ANTC by assuming that tax filer 1 is HtM.

Example 8 (MPC Adjustment)**.** $Y_1 = \$8,000$ (HtM), $Y_2 = \$12,000$

$$T_1 = \$800, \quad \hat{T}_1 = \$808, \quad T_2 = \$1,400, \quad \hat{T}_2 = \$1,424$$

$$\text{NTC} = 0.16, \quad \text{EMTR} = 0.16$$

$$\text{ANTC} = \frac{(\$808 - \$800)}{(\$8,080 - \$80,00) + (\$12,120 - \$12,000)} = 0.04$$

The ANTC is always less than the NTC because the ANTC only depends on changes in taxes of HtM tax filers, which is by definition less than total changes in taxes. Unless every tax filer is HtM, the NTC will therefore overestimate the cushioning effect of the tax system.

Through these examples, we hoped to build intuition for the NTCS and ANTCS. In the next section, we describe the data and present the workings of the MID and CCD. In doing so, we will discuss how the intuition presented here relates to each of these provisions.

4.4 Data and Descriptive Statistics

We estimate the destabilizing effect of the MID and CCD using data from the Survey of Consumer Finances (SCF). The SCF is a nationally representative triennial survey of U.S. households conducted by the Board of Governors of the Federal Reserve System in cooperation with the Statistics of Income Division (SOI) of the Internal Revenue Service (IRS). The SCF collects information on a broad array of assets, liabilities, and related information on items such as interest rates on loans. Notably, it contains information on the amount of mortgage holdings and applicable interest rates as well as on charitable contributions. In addition, the survey collects information on household demographics that are important for the estimation of federal income tax liability, including information on wage and capital income, number of dependents, and marital status.

We investigate the impact of the MID and CCD on automatic stabilizers for the years 1988 to 2009. The MID and CCD have unique characteristics and have differed in their respective historical prominence. In the following subsections, we briefly describe them. For the purpose of demonstrating how each policy can impact stabilization, we present some basic descriptive evidence from the SCF and, at times, from aggregate administrative data from the IRS SOI.

4.4.1 Mortgage Interest Deduction

The MID allows tax filers to reduce their taxable income by the amount of interest paid on home mortgages. Given that more than $300 billion in mortgage interest payments were made in 2012, the MID provides significant potential tax savings for homeowners. However, because the MID is an itemized deduction, it is not necessarily the case that all mortgage interest paid is technically eligible as a tax write off.

The MID reduces taxable income so that its primary effect will be to diminish the stabilizing effect of the tax system. The stabilizing effect of the MID, as demonstrated in Examples 4 and 5, depends on the extent to which it lowers the marginal tax rate faced by tax filers. This in turn depends on the extent to which tax filers are clustered around the marginal tax rate thresholds (and are therefore vulnerable to MID-induced bracket shifting).

Figure D.1 demonstrates how itemizers and MID claimants are distributed across income groups. It shows the average percentage of tax filers who itemize deductions (left) and the average percentage of all tax filers who claim the MID (right) broken down by income from 1980-2012 (in $2012), where the confidence bars indicate +/- one standard deviation for the particular income group over time. The increasing popularity of the MID across a wide range of the income distribution beyond $40,000 indicates that the MID is likely to cause at least some bracket shifting.

[Insert Figure D.1 about here]

4.4.2 Charitable Contributions Deduction

The deduction for charitable contributions is one of the oldest tax provisions. It was added to the tax code by the War Revenue Act of 1917, when income tax rates were sharply raised to pay for World War I. The concern was that raising the top rate from 15% to 67% would deprive tax filers of the disposable income from which they had been making charitable contributions. Like the MID, the CCD is an itemized deduction, so it allows tax payers who itemize deductions to reduce their taxable income by the amount paid for gifts to certain organizations with charitable status. Thus, the stabilization mechanisms relating to the MID are also at work in the CCD. We therefore expect the CCD to decrease the stabilizing ability of the tax system.

The left hand panel of Figure D.2 plots the number of tax filers claiming the CCD and the total amount of tax filer spending on charities over time. Since 1980, CCD-eligible spending has increased from under $50 billion to $200 billion per year (in $2012). The right hand panel of Figure D.2 shows annual average aggregate charitable giving broken down by income, where the confidence bars indicate +/- one standard deviation for the income group (in $2012). Aggregate giving captures both the average giving per tax filer and the distribution of tax filers across income groups. Unlike the top income groups, the largest group of aggregate givers—the $100,000 to $200,000 income group—is subject to bracket shifting. This is important because the destabilizing effects of the CCD work through the extent to which it lowers marginal tax rates via bracket shifting.

[Insert Figure D.2 about here]

4.5 Results

We estimate the NTC by running the SCF microdata through TAXSIM—the NBER's microsimulation tax model—to estimate each tax filer's tax liability with actual income and again after increasing all income items by 1%. Using the actual and counterfactual tax liabilities, we calculate the NTC according to Equation (4.1). To translate these estimates into MPC adjusted estimates that are relevant for demand stabilization, we identified HtM tax filers following the approach in Kaplan and Violante (2014). We leave a short discussion of this procedure and some of the benefits of this approach over other approaches for the Appendix.

Figure D.3 shows the proportion of HtM tax filers and the median income of HtM tax filers over time. Both the proportion of HtM tax filers and median income of HtM tax filers have remained fairly stable at around 28% and $30k, respectively. Because HtM tax filers make up less than 30% of the population (and a likely lower proportion of aggregate income, as indicated in Example 8), we expect the change in aggregate tax revenue that is relevant for stabilizing aggregate demand (ANTC) to be substantially less than the change in aggregate tax revenue (NTC).

[Insert Figure D.3 about here]

Table D.1 in the Appendix provides the results that we will now describe. We find that the tax system absorbed 25.4% of fluctuations in market income (the NTC), 3.7ppt of which would have otherwise been spent (the ANTC).[1] Finally, we conduct the counterfactual simulations in which we remove each of the tax provisions of interest, and estimate the NTCS_X and ANTCS_X for the MID and CCD. In the case of the MID, for example, we set each tax filer's mortgage interest paid to zero, estimate $\text{NTC}_{\text{MID}=0}$ and $\text{ANTC}_{\text{MID}=0}$, and then use these estimates

[1] See Dolls et al. (2012) for a discussion on how ANTC estimates significantly depend on the particular HtM definition employed, which can explain differences in the magnitudes of our ANTC estimates and the equivalent series produced by Auerbach and Feenberg (2000). See Kingi and Rozema (2015) for empirical evidence on this issue.

to estimate the NTCS_{MID} and $\text{ANTCS}_{\text{MID}}$ according to Equations (4.3) and (4.4). Figure D.4 plots our yearly NTCS and ANTCS estimates. On average between 1988 and 2009, the value of the NTCS for the MID and CCD was 50.2 and 38.2 basis points, respectively. This means that, on average, the MID and the CCD decreased the absorption effect of the tax system on disposable income by 1.98% (0.00502/0.254) and 1.50% (0.00382/0.254), respectively. The magnitudes of the effects of the tax expenditures on the ANTCS are smaller in absolute terms, but larger in relative terms. The average values of the ANTCS for the MID and CCD were 18.2 and 15.5 basis points, respectively. This means that the effect of the MID and CCD was to decrease the tax system's ability to absorb fluctuations in consumption by 4.92% (0.00182/0.037) and 4.20% (0.00155/0.037), respectively.

[Insert Figure D.4 about here]

These are relative estimates that say how much the tax system's automatic stabilizers are affected by the tax expenditure. However, because the effectiveness of the tax system in stabilizing the sensitivity of consumption to changes in market income is the measure of interest in the design of the tax system's automatic stabilizers, these relative estimates are not directly relevant to policy making. For example, our estimates imply a much larger destabilizing effect for an initial consumption sensitivity of 10% as opposed to, say, 50%.

We therefore normalize our estimates by the sensitivity of consumption to market income fluctuations in the absence of a tax system. As pointed out by Kingi and Rozema (2015), normalizing the ANTC in this manner reveals the extent to which the tax system as a whole reduces the response of consumption to market income changes. By normalizing the ANTCS, we reveal how a tax expenditure alters the ability of the tax system to reduce the sensitivity of consumption with respect to market income changes, which can be directly compared to equivalent measurements from the consumption response literature (Kniesner and Ziliak, 2002). These adjusted measures are ultimately of interest for policy makers not only in the design of tax expenditure and automatic stabilization policies, but also for the design of discretionary stabilization policies that target the residual fluctuations left over after the built-in stabilizers.

Figure D.5 plots our yearly adjusted estimates. We find that, on average, the MID and CCD increased the sensitivity of consumption to income fluctuations by 1.13% and 0.97%, respectively. To convert these changes in the sensitivity of consumption to dollar values, one needs to first impose a counterfactual business cycle fluctuation by assuming a size of the change in income. The eleven U.S. recessions in the post war period have witnessed drops in Gross Domestic Product (GDP) from as small as under 0.5% to as large as 5.1% (in 2008), with five recessions witnessing a drop between 2% and 4% (Federal Reserve Bank, 2015). To be able to compare the destabilizing effect of the tax expenditures with the stabilizing effect of enacted discretionary stabilizing policies that do not usually occur in mild recessions (e.g., tax rebates), we base our back of the envelope calculations on a somewhat severe 3% recession.[2]

Using the annual total personal income in the U.S., which was on average $10 trillion (in $2012) (row 7 of Table D.1), a 3% recession leads to an average annual reduction in personal income of $0.3 trillion (in $2012). Given the estimated consumption sensitivity in the presence of the tax system (on average, 13.5%, row 9 of

[2]Recessions are defined with respect to reductions in GDP rather than personal income subject to federal taxes. However, we follow Auerbach and Feenberg (2000) in assuming that a change in GDP is reflected in an identical change in aggregate personal income spread evenly across the population.

Table D.1), consumption in the recession therefore falls, on average, by $40.5 billion (in $2012). However, in the absence of the MID (CCD), consumption would have only fallen, on average, by $37.0 billion ($37.4 billion) (in $2012).[3] Importantly, the difference between the fall in consumption with and without the tax provision is exactly equal to the ANTCS multiplied by the change in total personal income, which highlights the appeal of our estimator. We calculate that the removal the MID (CCD) in light of a 3% recession would yield an average $3.5 billion ($3.1 billion) injection of consumption automatically into the economy (in $2012).

[Insert Figure D.5 about here]

To contextualize the magnitude of these estimates in terms of the size of discretionary stabilization policies, consider the 2001 tax rebate, which has been estimated to have increased aggregate consumption by $31.6 billion (in $2012) (Johnson et al., 2006). Our back of the envelope calculation therefore suggests that the removal of the MID and CCD would have stabilized consumption by about 11.1% ($3.5 billion/$31.6 billion) and 9.8% ($3.1 billion/$31.6 billion) of the change in consumption induced by the 2001 tax rebate, respectively.

4.6 Conclusion

One goal of the U.S. federal income tax system is to encourage particular economic activities by exempting them from taxation. Another is to automatically reduce

[3] The monetary change in consumption without a tax provision is calculated by the product of the consumption sensitivity in the presence of the tax system *but in the absence of the tax provision* and the change in total personal income.

fluctuations in the aggregate economy. Most assessments of the merits of tax expenditures have ignored their intrinsic relationship with automatic stabilization. In this article, we examine the interaction of these goals and show how measures of automatic stability relate to existing measures of tax expenditures and effective marginal tax rates.

We make two contributions. First, we consolidate concepts of automatic stabilizers, effective marginal tax rates, and tax expenditures into a single theoretical framework. Our main contribution is to exploit this framework to propose a method for estimating the effect of a tax expenditure on the ability of the tax system to act as an automatic stabilizer and estimate this measure using the Survey of Consumer Finances.

From 1988 to 2009, the Mortgage Interest Deduction (MID) and the Charitable Contributions Deduction (CCD) decreased the ability of the tax system to absorb fluctuations in income by an average of 4.92% and 4.20%, which increased the sensitivity of consumption to income fluctuations from a baseline of 0.14 by 1.13% and 0.97%, respectively. A back of the envelope calculation suggests that, in light of a 3% recession, the removal of the MID and CCD would have been to stabilize annual consumption by about an average of $3.5 and $3.1 billion (in 2012 dollars). Our findings suggest that, even relative to the size of discretionary stabilization policies, the MID and CCD substantially decrease the tax system's ability to stabilize demand.

It is our view that the desirability of tax expenditures ought to be assessed within the wider context of the income tax system. Our estimator speaks to the total effect of a tax expenditure on automatic stabilization. However, our methods are applicable to the analysis of any future tax reform proposal, whether it be the repeal of a current provision, the enactment of a new provision, or a modification of a prevailing provision. Instead of the hypothetical elimination of a tax provision to measure its stabilizing effect as we did here, the policy analyst simply conducts a simulation where the counterfactual calculation of tax liabilities, disposable income, and consumption takes place under the proposed policy regime. These simulations can be used to better inform policy makers on the stabilization impact of proposed tax reforms.

APPENDIX A

APPENDIX FOR CHAPTER 1

A.1 Tables

Table A.1: Wealth Shares

	2009	2010	2011	Mean
Native High Skill	0.873	0.868	0.863	0.867
Native Low Skill	0.038	0.036	0.034	0.036
Immigrant High Skill	0.078	0.085	0.091	0.085
Immigrant Low Skill	0.012	0.012	0.012	0.012

Notes: Constructed using data from the 2008 Panel of the Survey of Income and Program Participation. 2009 data extracted from the Topical Module in Wave 4, 2010 data from Wave 7 and 2011 data from Wave 10. Measure of wealth is the variable `THHTNW`, a household level variable defined as the sum of all assets less unsecured debt. Assets include home equity, net equity in vehicles, real estate equity, business equity, interest earning assets, equity in stock and mutual funds, and retirement accounts, such as IRA, KEOGH and 401(k) savings accounts. Debt includes credit card balances and amount owing on vehicles. Immigrants are defined as those not born in the United States which is denoted by the variable `EBORNUS` in the core module of each wave. High skill level is defined by those with a bachelors degree and above, as denoted in the `EEDUCATE` variable in the core module of each wave. Rows may not sum to one due to rounding.

Table A.2: Parameterization Results

Parameter	Data Source
Normalization	
$\kappa_L = 1$, $b_{HN} = b_{LN} = 0$	Normalization
$\epsilon = 0.5$, $\eta = 0.5$	Pissarides and Petrongolo (2001), Hosios (1990)
$\rho = 0.5$	Katz and Murphy (1992), Ottaviano and Peri (2012)
$\alpha = 0.33$	Standard Value
Direct Match	
$\beta = 0.9884$	4.76% annual risk free rate, Chassamboulli and Palivos (2014)
$\delta = 0.0182$	0.0061 monthly rate, Chassamboulli and Palivos (2014)
$Q_{HN} = 0.261$, $Q_{LN} = 0.570$ $Q_{HI} = 0.051$, $Q_{LI} = 0.119$	Average labor force shares (2005 - 2015), Current Population Survey
$a_{HN}(0) = 0.867$, $a_{LN}(0) = 0.036$ $a_{HI}(0) = 0.085$, $a_{LI}(0) = 0.012$	Waves 4, 7 and 10 of the 2008 panel of the Survey of Income and Program Participation
Method of Moments	
$s_{HN} = 0.0095$, $s_{HI} = 0.0127$ $s_{LN} = 0.0233$, $s_{LI} = 0.0216$ $\xi = 0.3629$, $\kappa_L = 0.2571$ $b_{HI} = -0.3222$, $b_{LI} = -0.5302$ $\gamma = 0.4781$	Unemployment rates: $u_{HN} = 0.034$, $u_{HI} = 0.045$, $u_{LN} = 0.087$, $u_{LI} = 0.081$ Wage premiums: $\frac{w_{HI}}{w_{HN}} = 0.9618$, $\frac{w_{LN}}{w_{HN}} = 0.651$, $\frac{w_{LI}}{w_{HN}} = 0.588$ Job finding rates: $f_H = 0.2329$, $f_L = 0.213$

Notes: Parameter A is normalized to set steady state output equal to one. A time period is one quarter. High-skilled workers in the CPS data are defined as those with at least a college education (`educ99`>14). Immigrants are defined as those workers born outside of the United States (`bpl`=9900). Sample is restricted to workers aged over 16 years who are in the labor force. See Table A.1 for description of SIPP variables.

Table A.3: Basic Model

	Low Skill Immigration		High Skill Immigration	
	Open	Closed	Open	Closed
	(1)	(2)	(3)	(4)
Long-Run Labor Market				
Native High Skill Wage (w_{HN})	0		0	
Native Low Skill Wage (w_{LN})	0		0	
Native High Skill Unemployment (u_{HN})	0		0	
Native Low Skill Unemployment (u_{LN})	0		0	
High Skill Good Price (p_H)	0		0	
Low Skill Good Price (p_L)	0		0	
Present Value Earnings				
Native High Skill Labor Income	0	-0.14	0	-0.14
Native Low Skill Labor Income	0	-0.14	0	-0.14
Welfare				
Native High Skill Long Run Welfare Gain (λ^*_{HN})	0	0.24	0	0.24
- Transition Cost	-0	-0.24	-0	-0.24
Native High Skill Welfare Gain (λ_{HN})	0	6×10^{-4}	0	6×10^{-4}
Native Low Skill Long Run Welfare Gain (λ^*_{LN})	0	0.24	0	0.24
- Transition Cost	-0	-0.24	-0	-0.24
Native Low Skill Welfare Gain (λ_{LN})	0	6×10^{-4}	0	6×10^{-4}

Notes: Model simulation showing the effects of a 1% immigration-induced increase in the labor force in an economy with homogeneous labor ($\rho = 1$, $s_{ij} = s$, $b_{ij} = 0$), homogeneous production ($\kappa_H = \kappa_L$, $\gamma = 0.5$) and per capita wealth holdings ($a_{ij}/Q_{ij} = a/Q$). Each entry corresponds to the percentage change in that row's variable under the assumption of that column. The percentage changes are in response to an influx of immigrants that increases the total labor force by 1%. Columns 1 and 2 represent the case where all new immigrants are low-skilled. Columns 3 and 4 represent the case where all new immigrants are high-skilled. Capital is assumed to flow freely from abroad in order to keep the return on capital constant in columns 1 and 3. In columns 2 and 4, the aggregate capital stock is fully determined by domestic wealth accumulation. The "Long-run" effects are the resulting percentage changes once the long run steady state is achieved. The compensating differential under "On Impact" are the percentage changes in the period in which the influx of new immigrants occur, which therefore accounts for the transition costs.

Table A.4: Capital Surplus Channel

	Low Skill Immigration		High Skill Immigration	
	Open	Closed	Open	Closed
	(1)	(2)	(3)	(4)
Long-Run Labor Market				
Native High Skill Wage (w_{HN})	0		0	
Native Low Skill Wage (w_{LN})	0		0	
Native High Skill Unemployment (u_{HN})	0		0	
Native Low Skill Unemployment (u_{LN})	0		0	
High Skill Good Price (p_H)	0		0	
Low Skill Good Price (p_L)	0		0	
Present Value Earnings				
Native High Skill Labor Income	0	-0.14	0	-0.14
Native Low Skill Labor Income	0	-0.14	0	-0.14
Welfare				
Native High Skill Long Run Welfare Gain (λ^*_{HN})	0	0.41	0	0.41
- Transition Cost	-0	-0.24	-0	-0.24
Native High Skill Welfare Gain (λ_{HN})	0	0.17	0	0.17
Native Low Skill Long Run Welfare Gain (λ^*_{LN})	0	0.11	0	0.11
- Transition Cost	-0	-0.24	-0	-0.24
Native Low Skill Welfare Gain (λ_{LN})	0	-0.13	0	-0.13

Notes: Model simulation showing the effects of a 1% immigration-induced increase in the labor force in an economy with homogeneous labor ($\rho = 1$, $s_{ij} = s$, $b_{ij} = 0$), homogeneous production ($\kappa_H = \kappa_L$, $\gamma = 0.5$) and calibrated per capita wealth holdings (a_{ij}/Q_{ij}). Each entry corresponds to the elasticity of that row's variable with respect to immigration under the assumption of that column. Columns 1 and 2 represent the case where all new immigrants are low-skilled. Columns 3 and 4 represent the case where all new immigrants are high-skilled. Capital is assumed to flow freely from abroad in order to keep the return on capital constant in columns 1 and 3. In columns 2 and 4, the aggregate capital stock is fully determined by domestic wealth accumulation.

Table A.5: Price Channel

	Low Skill Immigration		High Skill Immigration	
	Open	Closed	Open	Closed
	(1)	(2)	(3)	(4)
Long-Run Labor Market				
Native High Skill Wage (w_{HN})	0.44		-0.96	
Native Low Skill Wage (w_{LN})	-0.30		0.66	
Native High Skill Unemployment (u_{HN})	-0.22		0.48	
Native Low Skill Unemployment (u_{LN})	0.15		-0.33	
High Skill Good Price (p_H)	0.43		-0.93	
Low Skill Good Price (p_L)	-0.18		0.40	
Present Value Earnings				
Native High Skill Labor Income	0.43	0.31	-0.95	-1.12
Native Low Skill Labor Income	-0.29	-0.41	0.66	0.48
Welfare				
Native High Skill Long Run Welfare Gain (λ^*_{HN})	0.36	0.55	-0.79	-0.53
- Transition Cost	-0	-0.21	-0	-0.29
Native High Skill Welfare Gain (λ_{HN})	0.36	0.34	-0.79	-0.82
Native Low Skill Long Run Welfare Gain (λ^*_{LN})	-0.23	-0.01	0.51	0.83
- Transition Cost	-0	-0.21	-0	-0.29
Native Low Skill Welfare Gain (λ_{LN})	-0.23	-0.21	0.51	0.53

Notes: Model simulation showing the effects of a 1% immigration-induced increase in the labor force in an economy with imperfect substitution between high and low skilled goods ($\rho = 0.5 < 1$), homogeneous workers ($s_{ij} = s$, $b_{ij} = 0$), homogeneous production ($\kappa_H = \kappa_L$, $\gamma = 0.5$) and homogeneous wealth holdings ($a_{ij}/Q_{ij} = a/Q$). Each entry corresponds to the elasticity of that row's variable with respect to immigration under the assumption of that column. Columns 1 and 2 represent the case where all new immigrants are low-skilled. Columns 3 and 4 represent the case where all new immigrants are high-skilled. Capital is assumed to flow freely from abroad in order to keep the return on capital constant in columns 1 and 3. In columns 2 and 4, the aggregate capital stock is fully determined by domestic wealth accumulation.

Table A.6: Hiring Cost Channel

	Low Skill Immigration		High Skill Immigration	
	Open	Closed	Open	Closed
	(1)	(2)	(3)	(4)
Long-Run Labor Market				
Native High Skill Wage (w_{HN})	0		0.04	
Native Low Skill Wage (w_{LN})	0.04		0	
Native High Skill Unemployment (u_{HN})	0		-0.59	
Native Low Skill Unemployment (u_{LN})	-0.37		0	
High Skill Good Price (p_H)	0		0	
Low Skill Good Price (p_L)	0		0	
Present Value Earnings				
Native High Skill Labor Income	0	-0.15	0.24	0.09
Native Low Skill Labor Income	0.17	0.02	0	-0.15
Welfare				
Native High Skill Long Run Welfare Gain (λ^*_{HN})	0	0.18	0.14	0.39
- Transition Cost	-0	-0.21	-0	-0.25
Native High Skill Welfare Gain (λ_{HN})	0	-0.05	0.14	0.14
Native Low Skill Long Run Welfare Gain (λ^*_{LN})	0.08	0.32	0	0.20
- Transition Cost	-0	-0.21	-0	-0.25
Native Low Skill Welfare Gain (λ_{LN})	0.08	0.09	0	-0.04

Notes: Model simulation showing the effects of a 1% immigration-induced increase in the labor force in an economy with perfect substitution between high and low skilled goods ($\rho = 1$), heterogeneous workers (s_{ij}, b_{ij}), homogeneous production ($\gamma = 0.5$) and homogeneous wealth holdings ($a_{ij}/Q_{ij} = a/Q$). Each entry corresponds to the elasticity of that row's variable with respect to immigration under the assumption of that column. Columns 1 and 2 represent the case where all new immigrants are low-skilled. Columns 3 and 4 represent the case where all new immigrants are high-skilled. Capital is assumed to flow freely from abroad in order to keep the return on capital constant in columns 1 and 3. In columns 2 and 4, the aggregate capital stock is fully determined by domestic wealth accumulation.

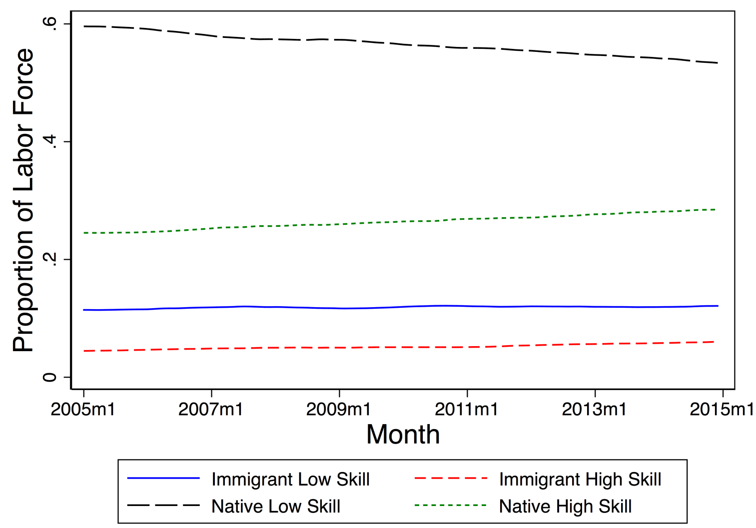
Table A.7: Main Quantitative Results

	Low Skill Immigration		High Skill Immigration	
	Open	Closed	Open	Closed
	(1)	(2)	(3)	(4)
Long-Run Labor Market				
Native High Skill Wage (w_{HN})	0.45		-0.91	
Native Low Skill Wage (w_{LN})	-0.27		0.67	
Native High Skill Unemployment (u_{HN})	-0.21		-0.04	
Native Low Skill Unemployment (u_{LN})	-0.30		-0.29	
High Skill Good Price (p_H)	0.43		-0.91	
Low Skill Good Price (p_L)	-0.19		0.40	
Present Value Earnings				
Native High Skill Labor Income	0.45	0.31	-0.74	-0.92
Native Low Skill Labor Income	-0.12	-0.25	0.69	0.50
Welfare				
Native High Skill Long Run Welfare Gain (λ^*_{HN})	0.17	0.51	-0.55	-0.08
- Transition Cost	-0	-0.21	-0	-0.30
Native High Skill Welfare Gain (λ_{HN})	0.17	0.30	-0.55	-0.38
Native Low Skill Long Run Welfare Gain (λ^*_{LN})	-0.12	-0.03	0.67	0.80
- Transition Cost	-0	-0.21	-0	-0.30
Native Low Skill Welfare Gain (λ_{LN})	-0.12	-0.24	0.67	0.50

Notes: Model simulation showing the effects of a 1% immigration-induced increase in the labor force for the calibrated economy. Each entry corresponds to the elasticity of that row's variable with respect to immigration under the assumption of that column. Columns 1 and 2 represent the case where all new immigrants are low-skilled. Columns 3 and 4 represent the case where all new immigrants are high-skilled. Capital is assumed to flow freely from abroad in order to keep the return on capital constant in columns 1 and 3. In columns 2 and 4, the aggregate capital stock is fully determined by domestic wealth accumulation.

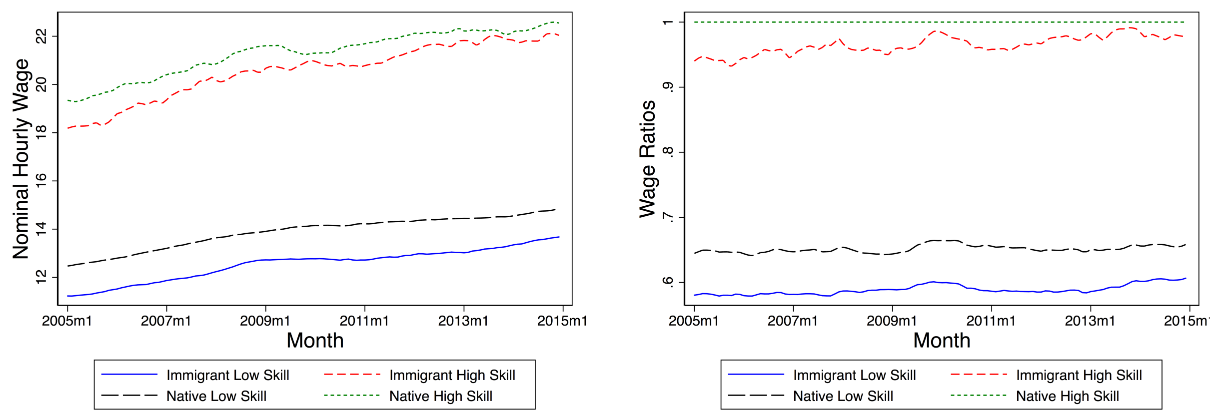
A.2 Figures

Figure A.1: Labor Force Shares



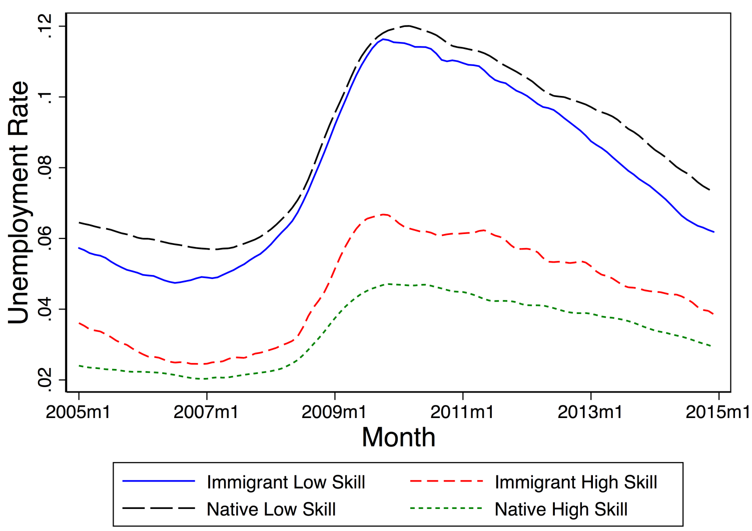
Notes: Own illustration using data from the January 2005 to December 2014 publicly available monthly samples from the Current Population Survey provided by IPUMS. High-skilled workers are defined as those with at least a college education (educ99 >= 15). Immigrants are defined as those workers born outside of the United States ($bpl \neq 9900$).

Figure A.2: Nominal Hourly Wage (LHS) and Hourly Wage as proportion of Native High Skilled Wage (RHS)



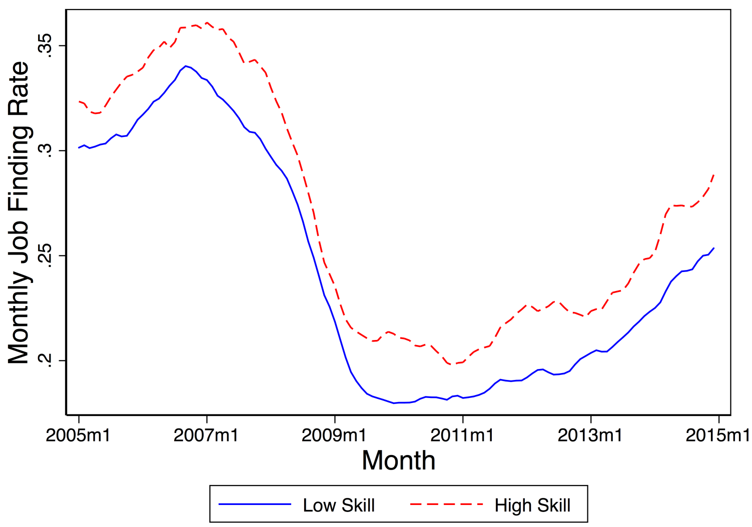
Notes: Own illustration using data from the outgoing rotation group of each monthly sample in the Current Population Survey between January 2005 to December 2014. Data provided by IPUMS. High-skilled workers are defined as those with at least a college education (educ99 >= 15). Immigrants are defined as those workers born outside of the United States ($bpl \neq 9900$). Variable used is hourly wage.

Figure A.3: Unemployment Rates



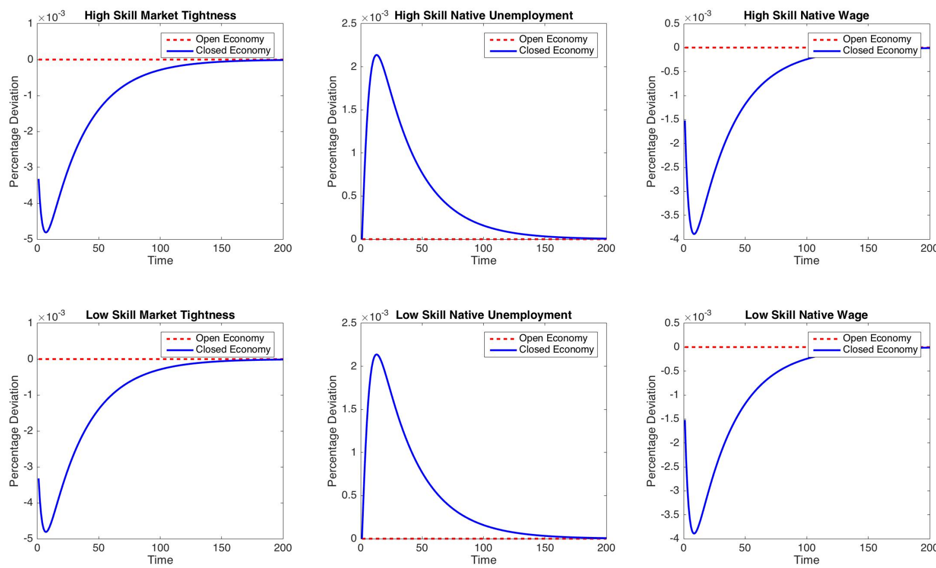
Notes: Own illustration using data from the January 2005 to December 2014 publicly available monthly samples from the Current Population Survey provided by IPUMS. High-skilled workers are defined as those with at least a college education (educ99 >= 15). Immigrants are defined as those workers born outside of the United States ($bpl \neq 9900$). To be included within the counts, a worker must be classified as within the labor force.

Figure A.4: Monthly Job Finding Probabilities



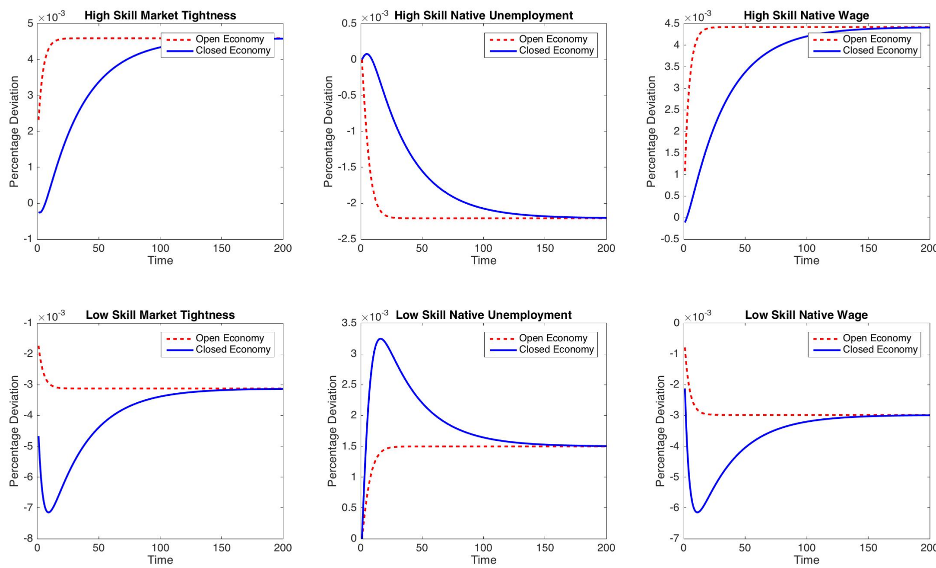
Notes: Own illustration using matched data from the January 2005 to December 2014 publicly available monthly samples from the Current Population Survey provided by IPUMS. High-skilled workers are defined as those with at least a college education (educ99 >= 15). Missing observations are assumed to be missing at random.

Figure A.5: Basic Model



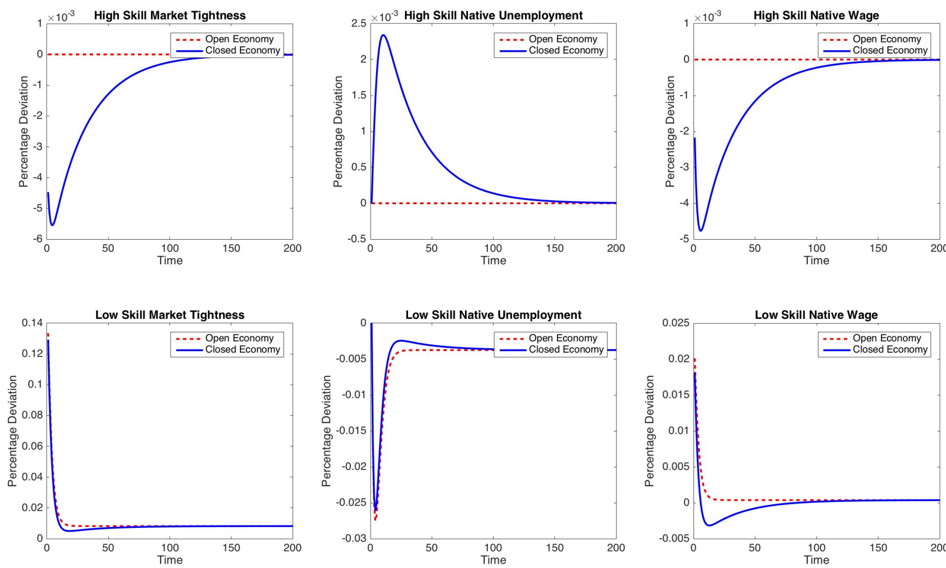
Notes: Own illustration showing the labor market transition dynamics from immigration with homogeneous labor, perfect intermediate good substitution. Simulation from an experiment in which the stock of high-skill immigrants increases by 1% of the total labor force at time 0. Calibration is a special case in which high and low skill goods are perfect substitutes ($\rho = 1$), and all workers are homogeneous so that worker separation rates ($s_{ij} = s$), outside options ($b_{ij} = 0$). Solid blue lines represent the behavior of variables in an economy where capital is determined solely by the capital accumulation decisions of resident household. Red dashed lines represent an economy open to foreign capital flows.

Figure A.6: Price Channel



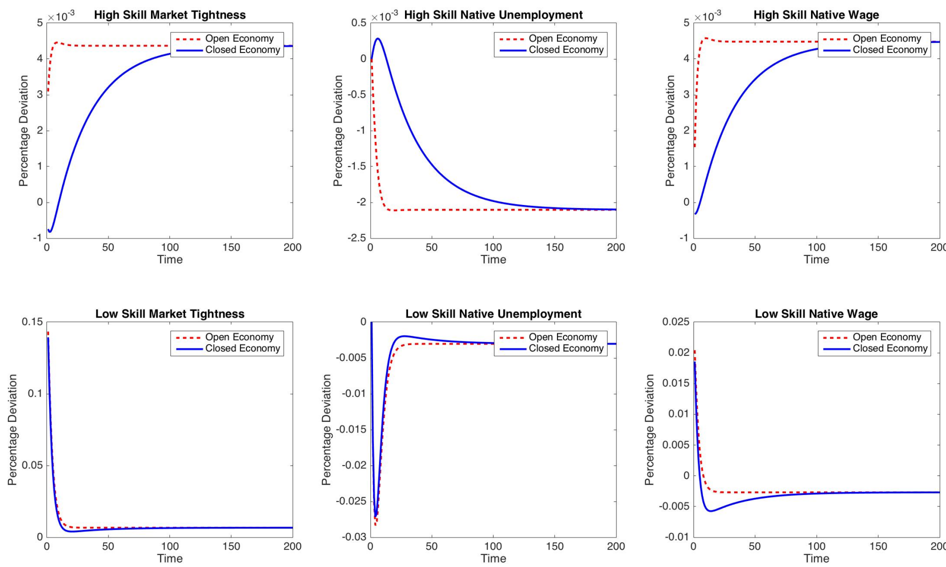
Notes: Own illustration showing the labor market transition dynamics from a 1% low-skill immigration-induced increase in the labor force in an economy with imperfect substitution between high and low skilled goods ($\rho = 0.5 < 1$), homogeneous workers ($s_{ij} = s$, $b_{ij} = 0$) and homogeneous production ($\kappa_H = \kappa_L$, $\gamma = 0.5$). Simulation from an experiment in which the stock of high-skill immigrants increases by 1% of the labor force. Solid blue lines represent the behavior of variables in an economy where capital is determined solely by the capital accumulation decisions of resident household. Red dashed lines represent an economy open to foreign capital flows.

Figure A.7: Hiring Cost Channel



Notes: Own illustration showing the labor market transition dynamics from a 1% low-skill immigration-induced increase in the labor force in an economy with perfect substitution between high and low skilled goods ($\rho = 1$), heterogeneous workers (s_{ij}, b_{ij}) and homogeneous production ($\gamma = 0.5$). Simulation from an experiment in which the stock of low-skill immigrants is increased by 1% of the labor force. Solid blue lines represent the behavior of variables in an economy where capital is determined solely by the capital accumulation decisions of resident household. Red dashed lines represent an economy open to foreign capital flows.

Figure A.8: Calibrated Model



Notes: Own illustration showing the labor market transition dynamics from a 1% low-skill immigration-induced increase in the United States labor force. Simulation from an experiment in which the stock of low-skill immigrants is increased by 1% of the labor force. Calibration is described in section 1.3. Solid blue lines represent the behavior of variables in an economy where capital is determined solely by the capital accumulation decisions of resident household. Red dashed lines represent an economy open to foreign capital flows.

A.3 Description of Moment Matching Calibration Procedure

The task of the procedure is to find values of the nine parameters in $\Theta_2 = \{b_{iN}, s_{ij}, \gamma, \kappa_L, \xi\}$ in order to match nine moments. The set of moments are three ratios of the wages of each worker type with respect to the wage of the high skilled native worker ($\frac{w_{ij}}{w_{HN}}$), four unemployment rates (one for each type of worker, u_{ij}), and two job finding rates (one for each labor market, f_i). The data sources for each moment are discussed in section 1.3.

For given values of the parameters in Θ_2 and the externally calibrated parameters in Θ_1, one can sequentially calculate the following steady state values. The targeted unemployment rates can be used to calculate the stocks of employed and unemployed workers according to the following equations.

$$U_{ij} = Q_{ij} \cdot u_{ij}$$
$$E_{ij} = Q_{ij} \cdot (1 - u_{ij})$$

Production stocks and the resulting prices of intermediate goods follow directly according to

$$\begin{aligned}
Y_i &= E_{iN} + E_{iI} \\
Z &= \left(\gamma Y_L^\rho + (1-\gamma) Y_H^\rho\right)^{1/\rho} \\
K &= \alpha \frac{Y}{r} \\
p_L &= AK^\alpha (1-\alpha)\gamma Y_L^{\rho-1} \left[\gamma Y_L^\rho + (1-\gamma)Y_H^\rho\right]^{(1-\alpha-\rho)/\rho} \\
p_H &= AK^\alpha (1-\alpha)(1-\gamma) Y_H^{\rho-1} \left[\gamma Y_L^\rho + (1-\gamma)Y_H^\rho\right]^{(1-\alpha-\rho)/\rho}
\end{aligned}$$

Using the targeted job finding probabilities, the firm value functions and the resulting wages can be calculated according to the following equations.

$$J_{ij} = \frac{(1-\eta)(p_i - b_{ij})}{1-\beta(1-s_{ij}-\eta f_i)}$$
$$w_{ij} = \eta\left(p_i + q f_i J_{ij}\right) + (1-\eta) b_{ij}$$

Finally, one can calculate the implied vacancy filling probabilities by

$$\theta_i = \left(\frac{f_i}{\xi}\right)^{1/(1-\epsilon)}$$
$$\mu_i = f_i/\theta_i$$

The preceding equations yield values which allow me to confirm whether the following nine equations are satisfied.

$$s_{ij}E_{ij} = f_i U_{ij} \qquad \text{for } ij \in \{HN, HI, LN, LI\} \tag{A.1}$$
$$w_{ij} = \left(\frac{w_{ij}}{w_{HN}}\right) w_{HN} \qquad \text{for } ij \in \{HI, LN, LI\} \tag{A.2}$$
$$\kappa_i = \beta\mu_i\left(\phi_i J_{iI} + (1-\phi_i) J_{iN}\right) \qquad \text{for } i \in \{H, L\} \tag{A.3}$$

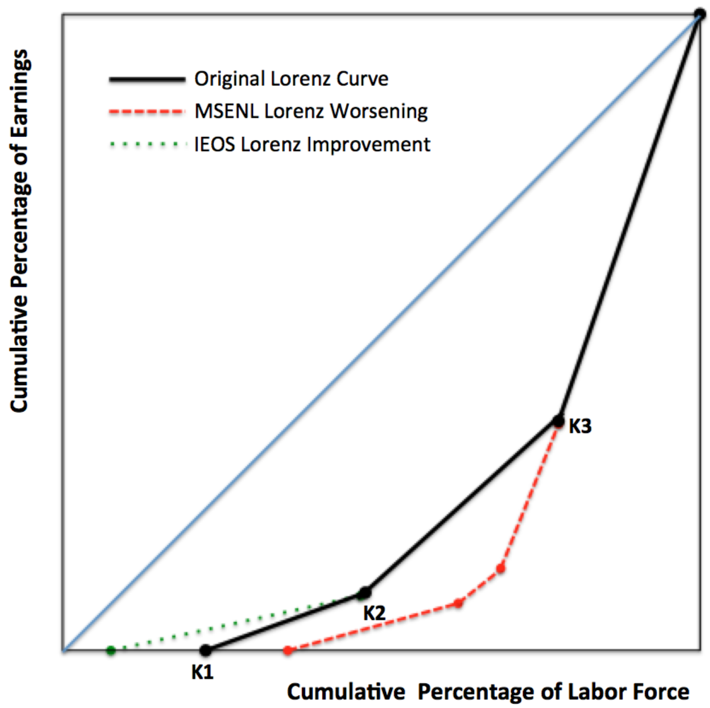
I choose values of the parameters in Θ_2 in order to satisfy equations (A.1)-(A.3). Because the matching procedure can be reduced to a set of nine simultaneous equations in nine unknowns, the system is perfectly identified and each moment can be matched exactly. The results and moments of this procedure are summarized in Table A.2.

APPENDIX B

APPENDIX FOR CHAPTER 2

B.1 Figures

Figure B.1: Lorenz Curve Comparisons



B.2 Derivation of Equations (2.8) - (2.9)

Equation (2.7) implies that

$$(1-\theta)\pi W_M = W_A(1-\theta\pi) \tag{B.1}$$

$$(1-\varphi)\pi W_M = W_A(1-\varphi\pi) \tag{B.2}$$

after substituting in the values of each of the search strategies V_i. These can be rearranged to yield

$$\frac{1}{\pi} = (1-\theta)\frac{W_M}{W_A} + \theta \tag{B.3}$$
$$\frac{1}{\pi} = (1-\varphi)\frac{W_M}{W_T} + \varphi \tag{B.4}$$

Equating the right hand sides of (B.3) and (B.4) yields

$$(1-\theta)\frac{W_M}{W_A} + \theta = (1-\varphi)\frac{W_M}{W_T} + \varphi$$

which can be rearranged to yield Equation (2.8) after substituting in for $W_T = \frac{Q_T}{L_T}$.

The definition of π in Equation (2.1) can be rearranged to yield

$$\begin{aligned}
&\pi(L_I + \theta L_{II} + \varphi L_{III}) = E_M \\
\Rightarrow &\pi(\frac{U}{1-\pi} + \theta\frac{L_A}{1-\theta\pi} + \varphi\frac{L_T}{1-\varphi\pi}) = E_M && \text{[by (2.2)-(2.5)]} \\
\Rightarrow &\pi(\frac{L - L_A - L_T - E_M}{1-\pi} + \theta\frac{L_A}{1-\theta\pi} + \varphi\frac{L_T}{1-\varphi\pi}) = E_M && \text{[by (2.6)]} \\
\Rightarrow &\frac{\pi}{1-\pi}(L - E_M - \frac{W_A}{W_M\pi}L_A - \frac{W_T}{W_M\pi}L_T) = E_M && \text{[by (B.1) and (B.2)]} \\
\Rightarrow &L_A = \frac{W_M\pi}{W_A}L - \frac{Q_T}{W_A} - \frac{W_M}{W_A}E_M \\
\Rightarrow &L_A = \frac{W_M}{W_A}\frac{1}{(1-\theta)\frac{W_M}{W_A} + \theta}L - \frac{Q_T}{W_A} - \frac{W_M}{W_A}E_M && \text{[by (B.3)]} \\
\Rightarrow &L_A = \frac{L}{1-\theta(1-\frac{W_A}{W_M})} - \frac{E_M W_M}{W_A} - \frac{Q_T}{W_A}
\end{aligned}$$

which is (2.9).

APPENDIX C

APPENDIX FOR CHAPTER 3

C.1 Tables

Table C.1: Average Effective Tax Rates (1995 - 2007)

	Labor Tax (τ_L)	Capital Tax (τ_K)
EU - 14	41	33
Germany	41	23
France	46	35
Italy	47	34
United Kingdom	28	46
Austria	50	24
Belgium	49	42
Denmark	47	51
Finland	49	31
Greece	41	16
Ireland	27	21
Netherlands	44	29
Portugal	31	23
Spain	36	30
Sweden	56	41

Notes: Tax rates are from Table 3 in Trabandt and Uhlig (2011), who calculated average effective tax rates from 1995 to 2007 using the methodology of Mendoza et al. (1994), and data from the AMECO database of the European Commission and the OECD database.

Table C.2: Self Financing Percentages for Tax Cuts

	Labor Tax Cuts				Capital Tax Cuts			
	No Migration		Migration		No Migration		Migration	
	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EU - 14	41	107	310	343	108	158	309	334
Germany	37	97	279	309	85	124	242	261
France	49	129	373	413	123	179	351	379
Italy	50	133	382	423	122	177	348	376
United Kingdom	31	81	233	258	123	180	352	380
Austria	51	134	387	428	101	147	288	311
Belgium	58	152	438	485	152	222	436	471
Denmark	58	153	441	488	189	276	540	583
Finland	53	138	398	441	117	170	333	360
Greece	34	89	257	285	72	104	205	221
Ireland	22	57	163	181	60	87	171	184
Netherlands	43	114	330	365	103	150	294	318
Portugal	26	68	195	216	69	101	198	214
Spain	33	88	254	281	92	134	263	284
Sweden	73	191	551	610	163	237	465	502

Notes: Columns 1 - 4 present the values of Θ_L stated in Equation (3.13) under different assumptions regarding labor supply elasticities (ϵ) and migration restrictions. These values represent the percentage of a labor tax cut that pays for itself. Columns 5 - 8 present the values of Θ_K stated in Equation (3.14), which represent the percentage of a capital tax cut that pays for itself. All numbers are expressed as percentages.

Table C.3: Labor Tax Laffer Curve Statistics

	Actual Tax Rate	Revenue Maximizing Tax Rate				Max Additional Tax Revenue			
		No Migration		Migration		No Migration		Migration	
		$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EU - 14	41	66	39	28	24	13	0	22	34
Germany	41	68	42	32	28	17	0	9	18
France	46	66	38	27	23	8	2	58	79
Italy	47	66	39	27	23	7	2	64	86
United Kingdom	28	64	35	21	17	25	1	5	11
Austria	50	68	42	32	28	7	2	59	81
Belgium	49	64	36	23	19	5	5	134	168
Denmark	47	63	33	18	14	5	5	173	212
Finland	49	66	39	29	25	7	3	73	98
Greece	41	69	44	35	31	20	0	4	10
Ireland	27	68	43	33	29	47	8	4	0
Netherlands	44	67	40	30	26	11	0	28	43
Portugal	31	68	42	32	28	34	4	0	1
Spain	36	67	40	29	25	21	0	5	11
Sweden	56	65	36	24	20	2	11	325	394

Notes: Column 1 restates the average effective labor tax rates from Table C.1. Columns 2 - 5 present the labor tax rates which maximize total government revenue under different assumptions regarding labor supply elasticities (ϵ) and migration restrictions, holding constant all parameter values and capital tax rates. These figures correspond to the location of the peak of the respective Laffer curves. Columns 6 - 9 present the amount of additional government revenue that would be gained if the country adopted the corresponding tax rates presented in Columns 2 - 5. These figures correspond to the height of the peak of the respective Laffer curves. All numbers are expressed as percentages.

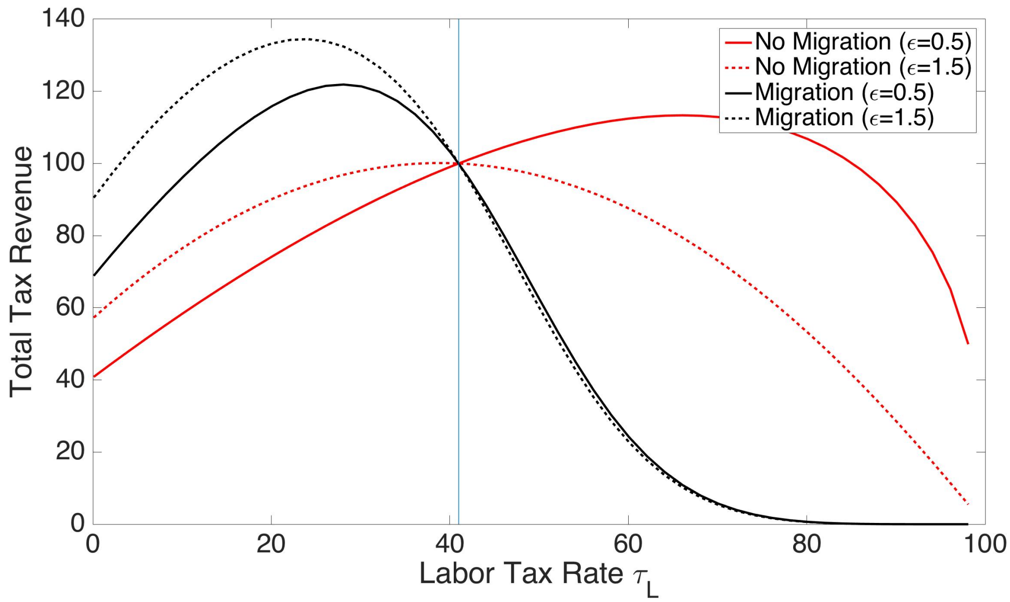
Table C.4: Capital Tax Laffer Curve Statistics

	Actual Tax Rate	Revenue Maximizing Tax Rate				Max Additional Tax Revenue			
		No Migration		Migration		No Migration		Migration	
		$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$	$\epsilon = 0.5$	$\epsilon = 1.5$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EU - 14	33	30	14	4	0	0	5	30	41
Germany	23	30	14	4	0	1	1	11	17
France	35	26	10	0	0	1	9	64	77
Italy	34	26	9	0	0	1	9	66	78
United Kingdom	46	39	25	23	17	1	9	22	35
Austria	24	24	7	0	0	0	4	41	47
Belgium	42	24	7	0	0	4	18	142	159
Denmark	51	26	9	0	0	8	29	233	264
Finland	31	24	7	0	0	0	7	64	73
Greece	16	30	14	4	0	2	0	4	8
Ireland	21	39	26	24	18	6	0	0	0
Netherlands	29	28	12	0	0	0	4	31	41
Portugal	23	37	23	19	13	3	0	0	3
Spain	30	33	18	12	7	0	2	10	18
Sweden	41	20	2	0	0	5	21	215	227

Notes: Column 1 restates the average effective capital tax rates from Table C.1. Columns 2 - 5 present the capital tax rates which maximize total government revenue under different assumptions regarding labor supply elasticities (ϵ) and migration restrictions, holding constant all parameter values and labor tax rates. These figures correspond to the location of the peak of the respective Laffer curves. Columns 6 - 9 present the amount of additional government revenue that would be gained if the country adopted the corresponding tax rates presented in Columns 2 - 5. These figures correspond to the height of the peak of the respective Laffer curves. All numbers are expressed as percentages.

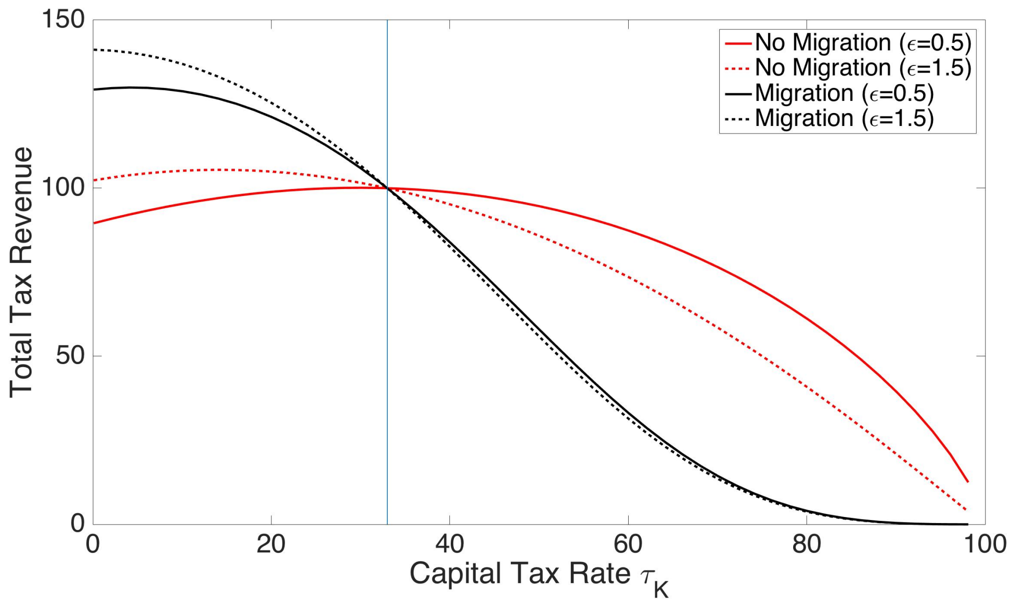
C.2 Figures

Figure C.1: EU-14 Labor Tax Laffer Curve



Notes: Own illustration. Simulation from model. Shows variations in total government tax revenue caused by changes in the labor tax rate, holding constant all parameter values and the capital tax rate at $\tau_K = 33\%$. Total tax revenues at the average labor tax rate of $\tau_L = 41\%$ are normalized to 100 and indicated by the solid vertical line. For comparison, results are provided for different labor supply elasticities (solid vs dashed lines) and for different assumptions regarding the mobility of labor (red vs black lines).

Figure C.2: EU-14 Capital Tax Laffer Curve



Notes: Own illustration. Simulation from model. Shows variations in total government tax revenue caused by changes in the capital tax rate, holding constant all parameter values and the labor tax rate at $\tau_L = 41\%$. Total tax revenues at the average capital tax rate of $\tau_K = 33\%$ are normalized to 100 and indicated by the solid vertical line. For comparison, results are provided for different labor supply elasticities (solid vs dashed lines) and for different assumptions regarding the mobility of labor (red vs black lines).

C.3 Derivation of Equations (3.11) and (3.12)

Hours worked are found by substituting the wage condition (3.1) into (3.5).

$$l = (1-\alpha)^{\frac{\epsilon}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon}{1+\epsilon(1-\chi(1-\alpha))}}K^{\frac{\epsilon\alpha\chi}{1+\epsilon(1-\chi(1-\alpha))}}N^{\frac{\epsilon(\chi(1-\alpha)-1)}{1+\epsilon(1-\chi(1-\alpha))}}$$

Substituting this expression back into the marginal product conditions in (3.1) yields the following expressions for wage and return on capital

$$w = (1-\alpha)^{\frac{1}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon(\chi(1-\alpha)-1)}{1+\epsilon(1-\chi(1-\alpha))}}K^{\frac{\alpha\chi}{1+\epsilon(1-\chi(1-\alpha))}}N^{\frac{\chi(1-\alpha)-1}{1+\epsilon(1-\chi(1-\alpha))}} \tag{C.3.1}$$

$$r = \alpha(1-\alpha)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}K^{\frac{-(1-\alpha\chi+\epsilon(1-\chi))}{1+\epsilon(1-\chi(1-\alpha))}}N^{\frac{\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}} \tag{C.3.2}$$

The free mobility of capital condition (3.4) along with (C.3.2) can be used to derive an explicit equation for the capital stock in terms of the working population and tax rates

$$K = \left[\frac{\alpha(1-\tau_K)}{\bar{r}}\right]^{\frac{1+\epsilon(1-\chi(1-\alpha))}{1-\chi\alpha+\epsilon(1-\chi)}}\left[(1-\alpha)^{\epsilon\chi(1-\alpha)}(1-\tau_L)^{\epsilon\chi(1-\alpha)}N^{\chi(1-\alpha)}\right]^{\frac{1}{1-\chi\alpha+\epsilon(1-\chi)}} \tag{C.3.3}$$

Recognizing that post tax wages can be written

$$(1-\tau_L)w = (1-\alpha)^{\frac{1}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{1}{1+\epsilon(1-\chi(1-\alpha))}}K^{\frac{\alpha\chi}{1+\epsilon(1-\chi(1-\alpha))}}N^{\frac{\chi(1-\alpha)-1}{1+\epsilon(1-\chi(1-\alpha))}}$$

implies that the free migration condition (3.7) can be expressed as follows

$$1 = \left(\frac{1-\tau_L}{1-\tau_{L*}}\right)^{\frac{1}{1+\epsilon(1-\chi(1-\alpha))}}\left(\frac{K}{K_*}\right)^{\frac{\alpha\chi}{1+\epsilon(1-\chi(1-\alpha))}}\left(\frac{N}{N_*}\right)^{\frac{\chi(1-\alpha)-1}{1+\epsilon(1-\chi(1-\alpha))}}$$

which can be rearranged after recognizing that $N_* = \bar{N} - N$ and substituting in (C.3.3) to yield an explicit expression for population

$$N = \bar{N}\left[\left(\frac{1-\tau_{L*}}{1-\tau_L}\right)^{\frac{1-\chi\alpha}{1-\chi}}\left(\frac{1-\tau_{K*}}{1-\tau_K}\right)^{\frac{\alpha\chi}{1-\chi}} + 1\right]^{-1} \tag{C.3.4}$$

The static estimates for the change in government revenue caused by a change in a particular tax rate are equal to the tax base of that tax, and can be written as follows

$$\left.\frac{\partial R}{\partial \tau_L}\right|_{\text{static}} = wL = (1-\alpha)(1-\alpha)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}} K^{\frac{\alpha\chi(1+\epsilon)}{1+\epsilon(1-\chi(1-\alpha))}} N^{\frac{\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}$$
$$\left.\frac{\partial R}{\partial \tau_K}\right|_{\text{static}} = rK = \alpha(1-\alpha)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}} K^{\frac{\alpha\chi(1+\epsilon)}{1+\epsilon(1-\chi(1-\alpha))}} N^{\frac{\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}$$

Substituting these expressions into (3.8) allows total government revenue to be expressed as follows

$$R = (1-\alpha)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}(1-\tau_L)^{\frac{\epsilon\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}} K^{\frac{\alpha\chi(1+\epsilon)}{1+\epsilon(1-\chi(1-\alpha))}} N^{\frac{\chi(1-\alpha)}{1+\epsilon(1-\chi(1-\alpha))}}(\alpha\tau_K + (1-\alpha)\tau_L) \tag{C.3.5}$$

from which we can derive the following general expressions

$$\frac{\partial R}{\partial \tau_K} = \frac{1}{\alpha}\left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Static}} \times \left[\alpha + \frac{(\alpha\tau_K + (1-\alpha)\tau_L)\chi}{1+\epsilon(1-\chi(1-\alpha))}\left(\frac{\alpha(1+\epsilon)}{K}\frac{\partial K}{\partial \tau_K} + \frac{(1-\alpha)}{N}\frac{\partial N}{\partial \tau_K}\right)\right] \tag{C.3.6}$$
$$\frac{\partial R}{\partial \tau_L} = \left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Static}} \times \left[1 + \frac{(\alpha\tau_K + (1-\alpha)\tau_L)\chi}{(1+\epsilon(1-\chi(1-\alpha)))(1-\alpha)}\left(\frac{\alpha(1+\epsilon)}{K}\frac{\partial K}{\partial \tau_L} + \frac{(1-\alpha)}{N}\frac{\partial N}{\partial \tau_L} - \frac{\epsilon(1-\alpha)}{1-\tau_L}\right)\right] \tag{C.3.7}$$

Taking derivatives of (C.3.4) reveals the effect of tax changes on population

$$\frac{\partial N}{\partial \tau_K} = -N\frac{N_*}{\bar{N}}\frac{\chi\alpha}{1-\chi}\frac{1}{1-\tau_K} \tag{C.3.8}$$
$$\frac{\partial N}{\partial \tau_L} = -N\frac{N_*}{\bar{N}}\frac{1-\chi\alpha}{1-\chi}\frac{1}{1-\tau_L} \tag{C.3.9}$$

and derivatives of (C.3.3) reveals the same for capital stock

$$\frac{\partial K}{\partial \tau_K} = -\frac{K}{(1-\chi\alpha+\epsilon(1-\chi))(1-\tau_K)}\left[1+\epsilon(1-\chi(1-\alpha)) + \frac{\chi^2\alpha(1-\alpha)}{1-\chi}\frac{N_*}{\bar{N}}\right] \tag{C.3.10}$$
$$\frac{\partial K}{\partial \tau_L} = -\frac{K\chi(1-\alpha)}{(1-\chi\alpha+\epsilon(1-\chi))(1-\tau_L)}\left[\epsilon + \frac{1-\chi\alpha}{1-\chi}\frac{N_*}{\bar{N}}\right] \tag{C.3.11}$$

The “closed” economy cases in which migration is restricted are found by setting $N_* = 0$. Substituting the appropriate versions of (C.3.8) - (C.3.11) into (C.3.6) and

(C.3.7) yields the required expressions.

$$\left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Dynamic}} = \left[1 - \frac{\chi(\alpha\tau_K + (1-\alpha)\tau_L)}{(1-\chi\alpha+\epsilon(1-\chi))(1-\tau_L)}\left(\epsilon + \frac{1-\chi\alpha}{1-\chi}\frac{N_*}{\bar{N}}\right)\right] \times \left.\frac{\partial R}{\partial \tau_L}\right|_{\text{Static}}$$

$$\left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Dynamic}} = \left[1 - \frac{\chi(\alpha\tau_K + (1-\alpha)\tau_L)}{(1-\chi\alpha+\epsilon(1-\chi))(1-\tau_K)}\left(1 + \epsilon + \frac{(1-\alpha)\chi}{1-\chi}\frac{N_*}{\bar{N}}\right)\right] \times \left.\frac{\partial R}{\partial \tau_K}\right|_{\text{Static}}$$

C.4 Propositions

Proposition 4. *Consider the following Cobb Douglas production function*

$$Y = \left(K^{\alpha}L^{1-\alpha}\right)^{\chi}$$

If $\chi = 1$ and K and L are mobile and determined by their own independent marginal product conditions, no unique solution for K and L exists.

Proof. Let the marginal productivity conditions be as follows

$$\frac{\partial Y}{\partial K} = \alpha\chi K^{\alpha\chi-1}L^{\chi(1-\alpha)} = A$$

$$\frac{\partial Y}{\partial L} = (1-\alpha)\chi K^{\alpha\chi}L^{\chi(1-\alpha)-1} = B$$

Taking logs and rearranging yields the following system of linear equations

$$\begin{pmatrix} \alpha\chi - 1 & \chi(1-\alpha) \\ \alpha\chi & \chi(1-\alpha)-1 \end{pmatrix}\begin{pmatrix} \log(K) \\ \log(L) \end{pmatrix} = \begin{pmatrix} \log\left(\frac{A}{\alpha\chi}\right) \\ \log\left(\frac{B}{(1-\alpha)\chi}\right) \end{pmatrix}$$

which has a unique solution if and only if

$$\chi \neq 1$$

□

The intuition behind this result is that when production has constant returns to scale, each marginal productivity condition merely pins down the *ratio* of capital to labor rather than the *levels* of each. The system of equations reduces to two equations in one unknown and therefore becomes over identified.

Proposition 5. *Provided that a Laffer Curve has an interior peak, that peak shifts to the left as the labor supply elasticity increases and in the presence of international migration.*

Proof. Setting $\frac{\partial R}{\partial \tau_K}|_{\text{Dynamic}} = 0$ and $\frac{\partial R}{\partial \tau_L}|_{\text{Dynamic}} = 0$ yields the following expressions for the interior peaks of each Laffer Curve.

$$\tau_L^* = \frac{1 - \chi\alpha + \epsilon(1-\chi) - \alpha\chi\left(\epsilon + \frac{1-\chi\alpha}{1-\chi}\frac{N^*}{\bar{N}}\right)\tau_K}{1 - \chi\alpha + \epsilon(1-\chi) + (1-\alpha)\chi\left(\epsilon + \frac{1-\chi\alpha}{1-\chi}\frac{N^*}{\bar{N}}\right)}$$

$$\tau_K^* = \frac{1 - \chi\alpha + \epsilon(1-\chi) - (1-\alpha)\chi\left(1 + \epsilon + \frac{1-\alpha}{1-\chi}\chi\frac{N^*}{\bar{N}}\right)\tau_L}{1 - \chi\alpha + \epsilon(1-\chi) + \alpha\chi\left(1 + \epsilon + \frac{1-\alpha}{1-\chi}\chi\frac{N^*}{\bar{N}}\right)}$$

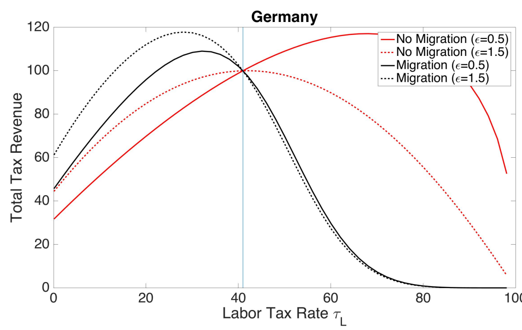
It follows that

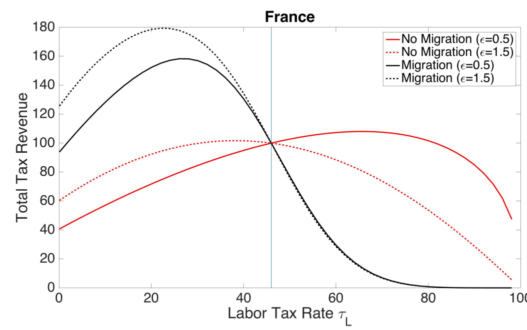
$$\frac{\partial \tau_K^*}{\partial \epsilon} < 0 \, , \; \frac{\partial \tau_K^*}{\partial (N_*/N)} < 0 \, , \; \frac{\partial \tau_L^*}{\partial \epsilon} < 0 \, , \; \frac{\partial \tau_L^*}{\partial (N_*/N)} < 0$$

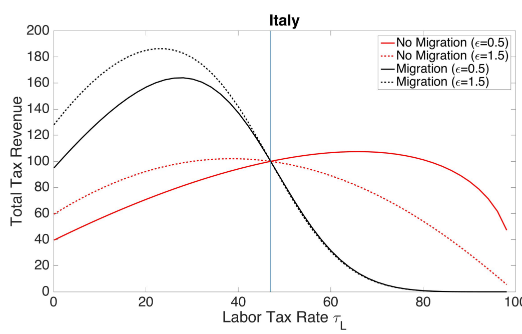
as required. □

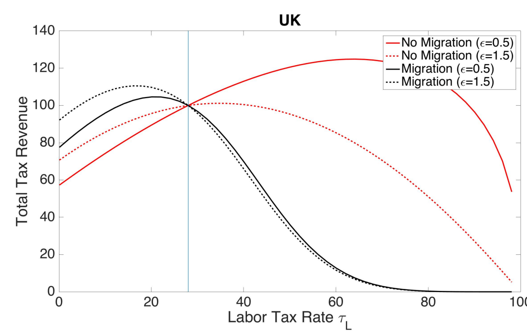
C.5 Individual Country Labor Tax Laffer Curves

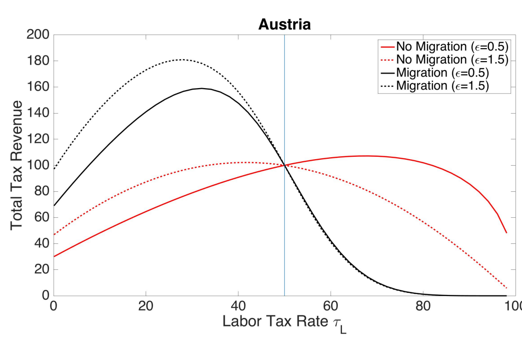
The following figures provide the same information as Figure C.1 for each of the individual European countries.

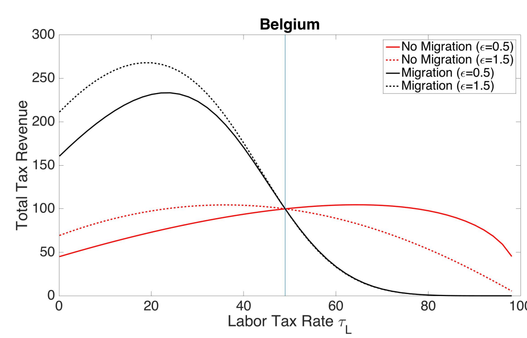


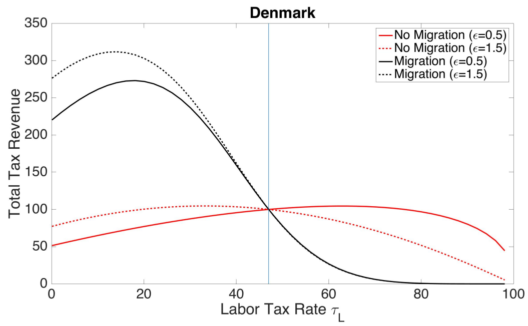


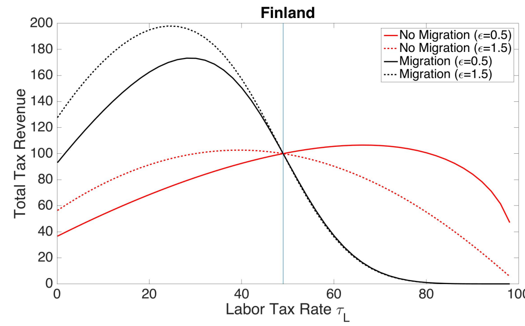


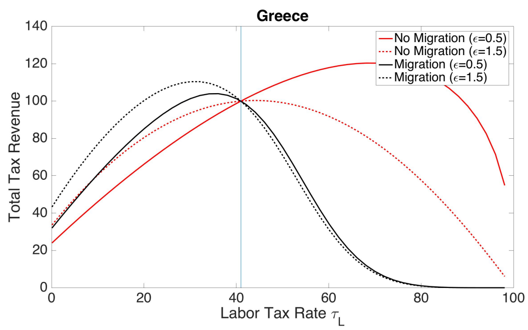


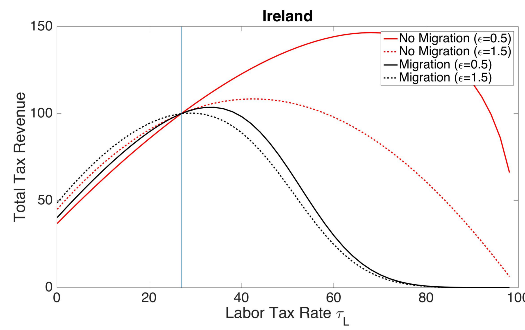


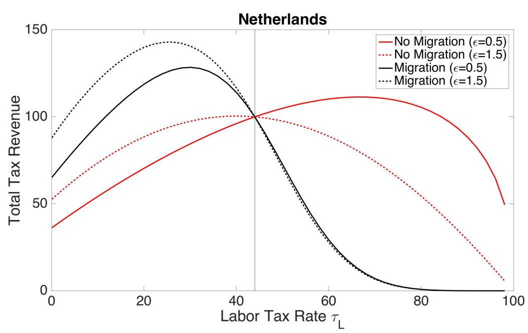


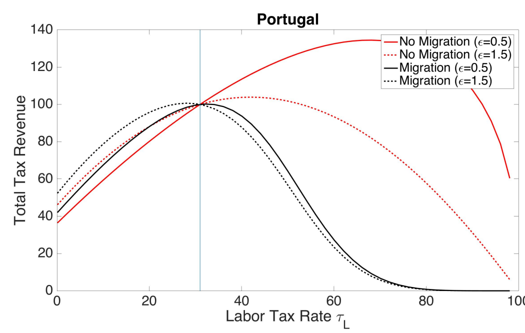

Denmark
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 50 100 150 200 250 300 350
0 20 40 60 80 100

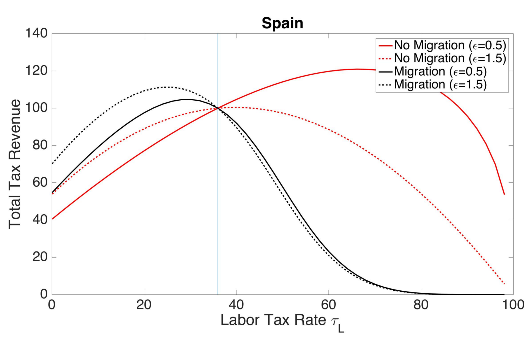

Finland
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 20 40 60 80 100 120 140 160 180 200
0 20 40 60 80 100

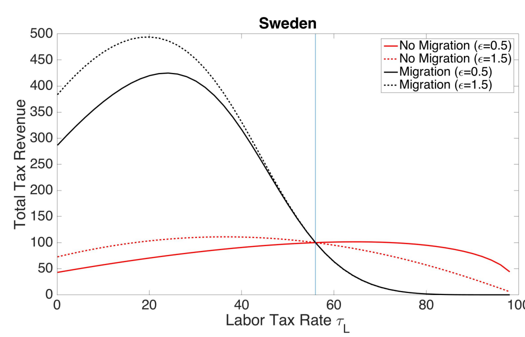

Greece
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 20 40 60 80 100 120 140
0 20 40 60 80 100


Ireland
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 50 100 150
0 20 40 60 80 100


Netherlands
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 50 100 150
0 20 40 60 80 100

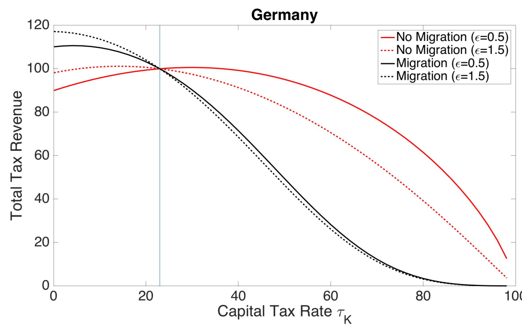

Portugal
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 20 40 60 80 100 120 140
0 20 40 60 80 100

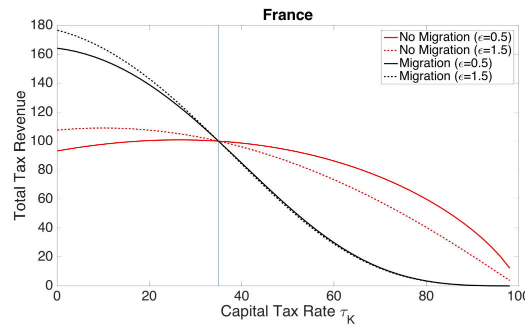

Spain
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 20 40 60 80 100 120 140
0 20 40 60 80 100

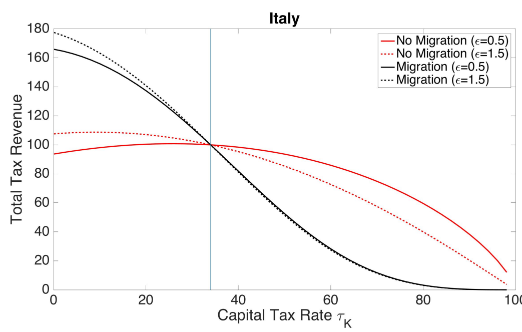

Sweden
Total Tax Revenue
Labor Tax Rate τ_L
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
0 50 100 150 200 250 300 350 400 450 500
0 20 40 60 80 100

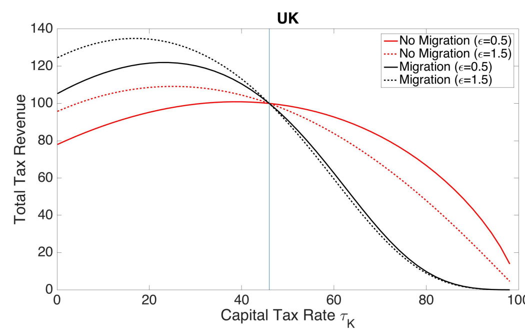
C.6 Individual Country Capital Tax Laffer Curves

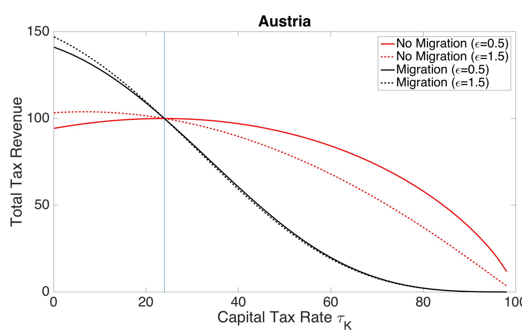
The following figures provide the same information as Figure C.2 for each of the individual European countries.

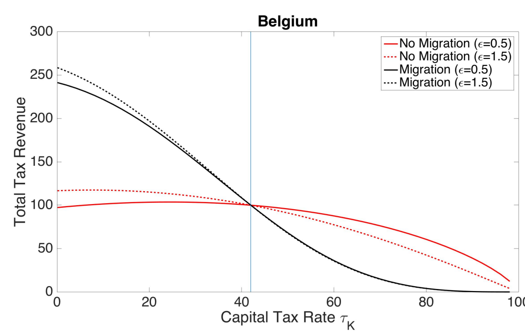


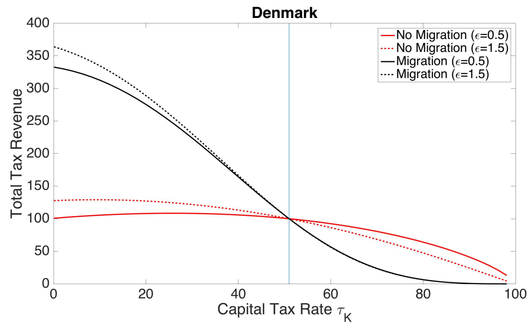


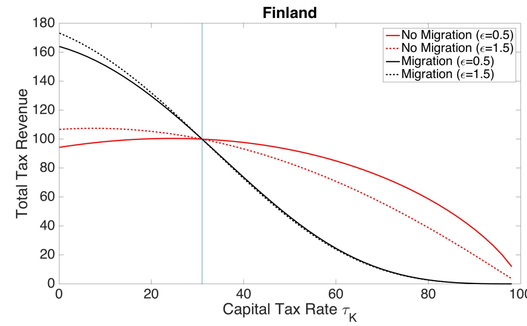


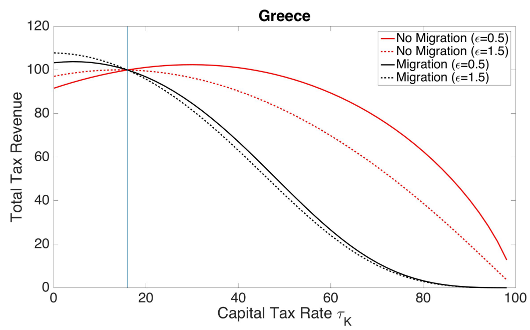


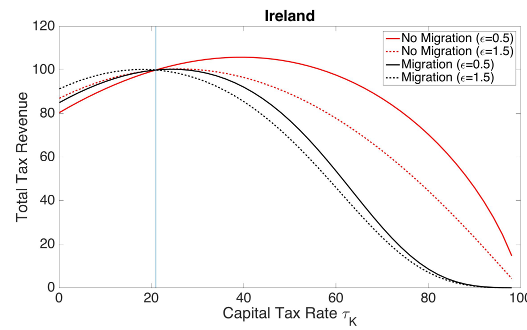


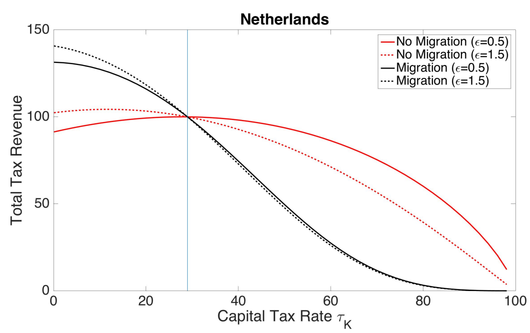


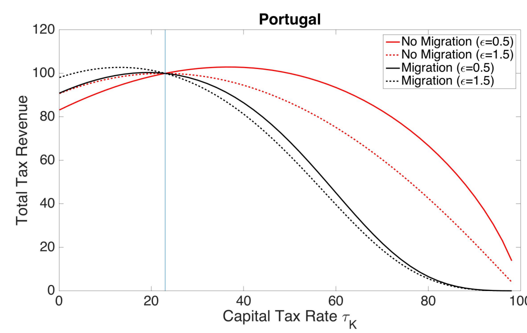

Denmark
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100

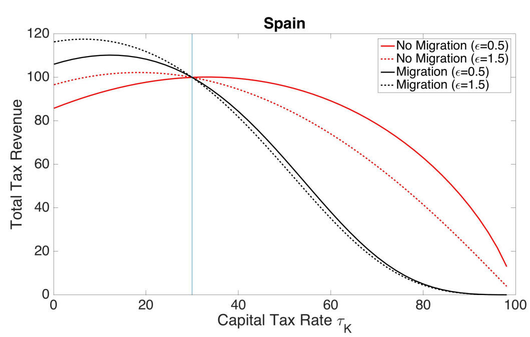

Finland
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
20
40
60
80
100
120
140
160
180
0
20
40
60
80
100

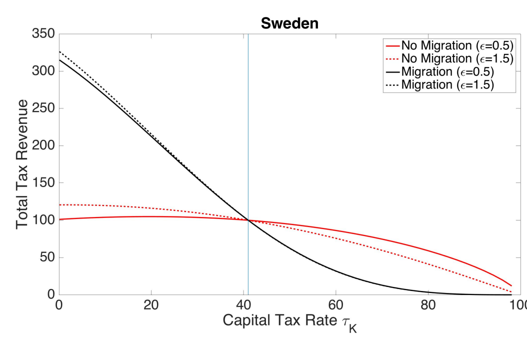

Greece
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
20
40
60
80
100
120
0
20
40
60
80
100


Ireland
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
20
40
60
80
100
120
0
20
40
60
80
100


Netherlands
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
50
100
150
0
20
40
60
80
100


Portugal
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
20
40
60
80
100
120
0
20
40
60
80
100


Spain
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
20
40
60
80
100
120
0
20
40
60
80
100

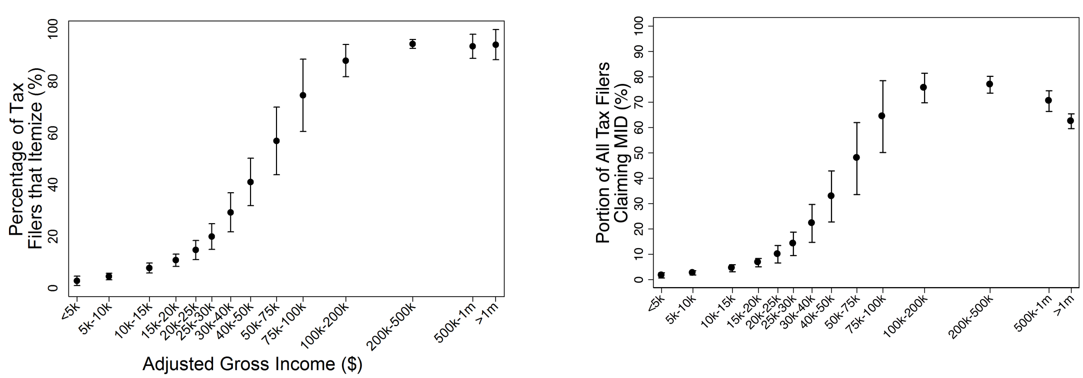

Sweden
No Migration (ϵ=0.5)
No Migration (ϵ=1.5)
Migration (ϵ=0.5)
Migration (ϵ=1.5)
Total Tax Revenue
Capital Tax Rate τ_K
0
50
100
150
200
250
300
350
0
20
40
60
80
100

APPENDIX D

APPENDIX FOR CHAPTER 4

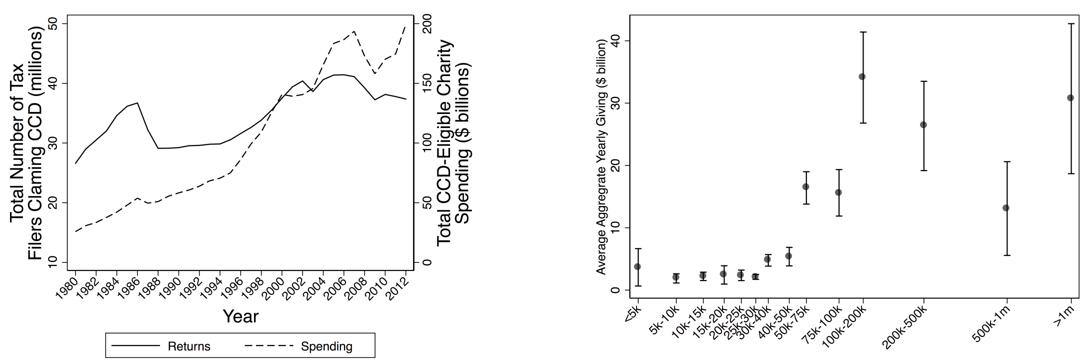
D.1 Tables and Figures

Figure D.1: Percentage of Tax Filers Itemizing Deductions (left) and Claiming the Mortgage Interest Deduction (right) by Income



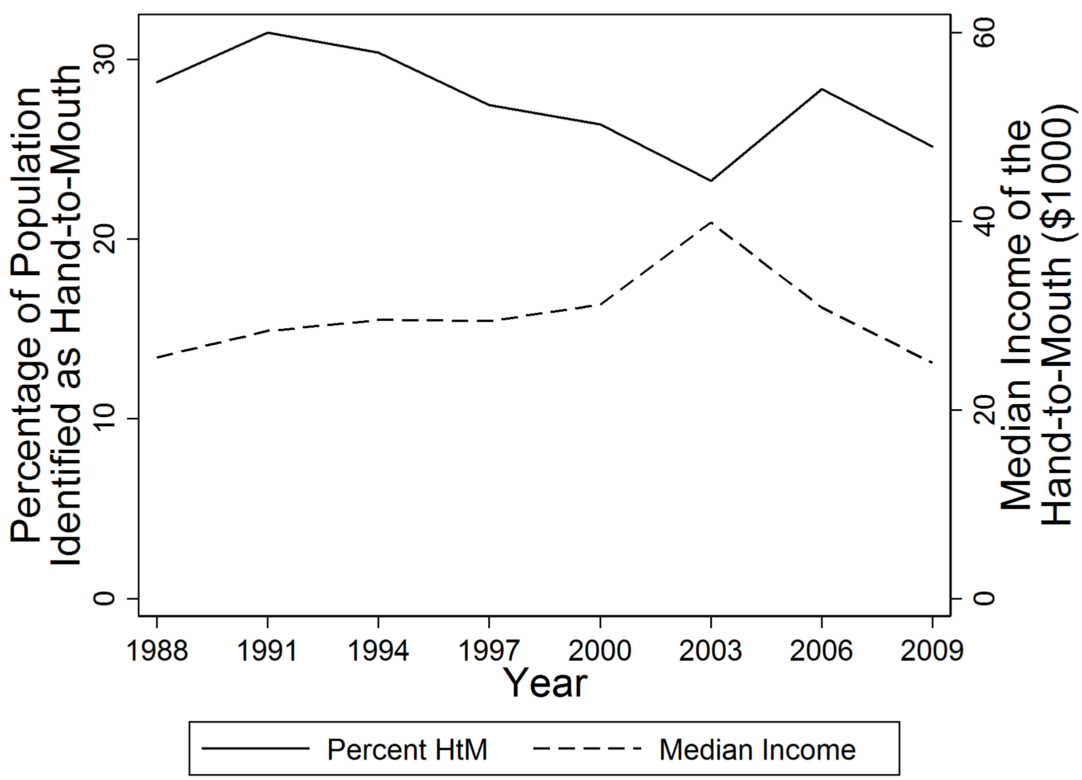
Notes: Own illustration using data from the Internal Revenue Service's Statistics of Income Tax Stats on Individual Tax Returns. The panels report the averages in the given income bracket from 1980 to 2012 (adjusted to 2012 dollars) with confidence bars indicating +/- one standard deviation.

Figure D.2: Total Yearly Tax Filers Claiming the Charitable Contributions Deduction and Total Eligible Charity Spending (left) and Aggregate Charitable Giving by Income (right)



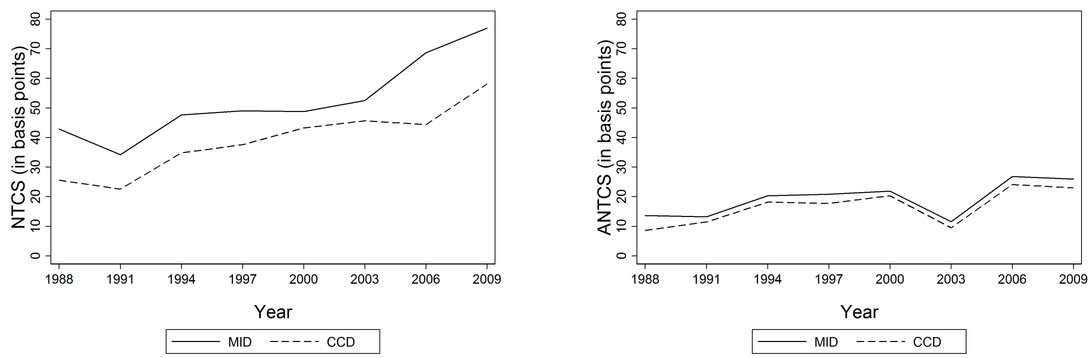
Notes: Own illustration using data from the Internal Revenue Service's Statistics of Income Tax Stats on Individual Tax Returns (left). Own illustration using data from the Survey of Consumer Finances (right). The points in the right hand panel indicate the average aggregate giving in the given income bracket from 1988 to 2009 (adjusted to 2012 dollars) with confidence bars indicating +/- one standard deviation.

Figure D.3: Percentage of U.S. Population Identified as Hand-to-Mouth (HtM) and Median Income of HtM Households Over Time



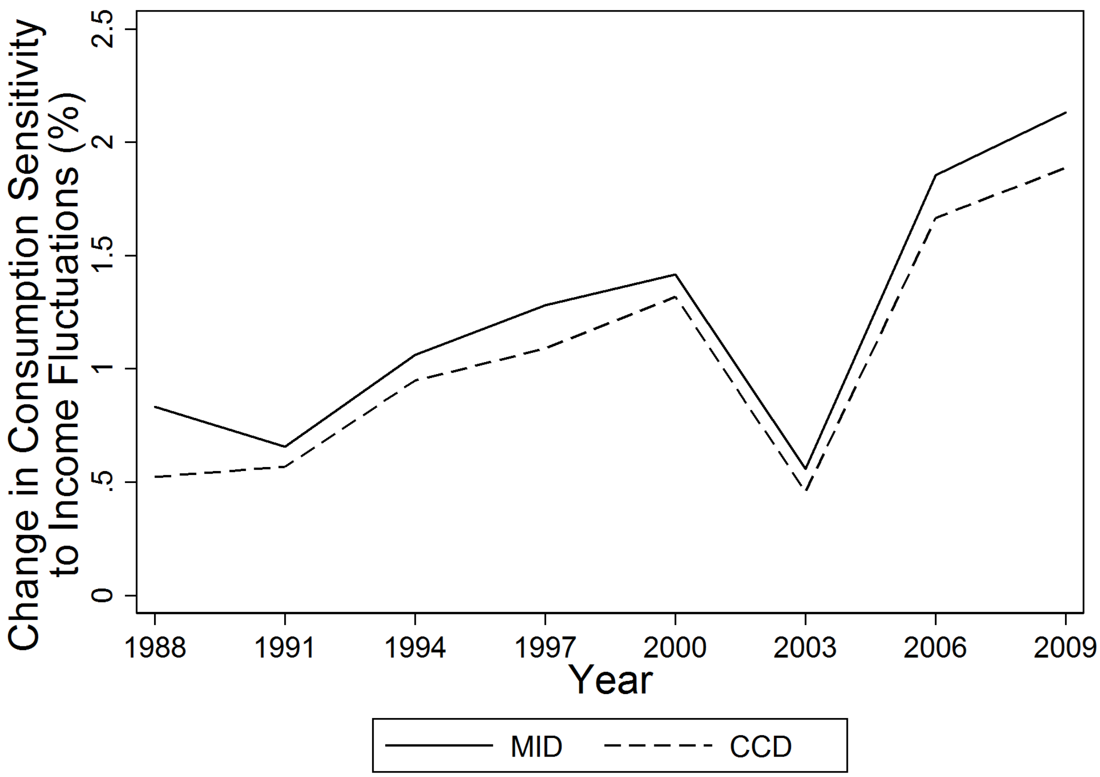
Notes: Own illustration using data from the Survey of Consumer Finances, 1988 to 2009. The median income has been adjusted by CPI to 2012 dollars.

Figure D.4: Normalized Tax Change Shifter (NTCS) (left) and MPC Adjusted NTCS (ANTCS) (right) for the Mortgage Interest Deduction (MID) and the Charitable Contributions Deduction (CCD)



Notes: Own illustration using data from the Survey of Consumer Finances, 1988 to 2009. Each line represents the change in the stabilizing effect of the tax system that would have occurred without the particular tax provision as indicated in the legend. The NTCS measures the destabilizing effect of a tax expenditure on disposable income, which we show can be interpreted as (1) the extra proportion of a fluctuation in market income that would be absorbed by the tax system in the absence of tax provision, (2) the sensitivity of the tax expenditure to income changes, or (3) the sensitivity of the effective marginal tax rates to the tax expenditure, where we estimate the change with respect to the hypothetical elimination of a tax expenditure rather than a marginal ($1) change in income commonly used throughout the empirical macroeconomics literature. The ANTCS for each tax expenditure estimates the extra amount of consumption, as a proportion of a fluctuation in market income, that the tax system would have absorbed in the absence of the tax provision.

Figure D.5: The Increase in Sensitivity of Consumption to Income Fluctuations Induced by the Mortgage Interest Deduction (MID) and the Charitable Contributions Deduction (CCD)



Notes: Own illustration using data from the Survey of Consumer Finances, 1988 to 2009.

Table D.1: Yearly and Average Estimates of the Destabilizing Effects of the Mortgage Interest Deduction (MID) and the Charitable Contributions Deduction (CCD)

	Year									
Measure	1988	1991	1994	1997	2000	2003	2006	2009	Mean	St. Dev.
NTC (%)	23.6	24.5	25.9	26.7	28.3	24.9	24.6	23.9	25.4	1.7
ANTC (%)	3.3	4.3	4.2	3.5	3.6	5.0	2.6	2.1	3.7	0.9
NTCS (basis points)										
MID	42.8	34.2	47.6	49.0	48.7	52.5	68.6	76.9	50.2	13.2
CCD	25.6	22.5	34.8	37.6	43.2	45.6	44.4	58.1	38.2	12.2
ANTCS (basis points)										
MID	13.6	13.2	20.3	20.8	21.8	11.6	26.8	25.9	18.2	5.4
CCD	8.6	11.4	18.1	17.7	20.3	9.5	24.1	23.0	15.5	5.6
Total Personal Income (in $2012 trillion)										
	8.5	8.2	8.9	9.8	11.1	11.4	12.5	12.4	10.0	1.6
Consumption Sensitivity in the Absence of the Tax System (%)										
	16.4	20.1	19.1	16.2	15.4	20.7	14.5	12.2	17.2	3.0
Consumption Sensitivity in the Presence of the Tax System (%)										
	13.1	15.8	14.9	12.8	11.8	15.8	11.8	10.0	13.5	2.2
Change in the Consumption Sensitivity Induced By the Expenditure (%)										
MID	0.83	0.67	1.06	1.28	1.42	0.59	1.85	2.13	1.13	0.54
CCD	0.52	0.57	0.95	1.09	1.32	0.46	1.67	1.89	0.97	0.52
Converted to Dollars (in £2012 billions)										
MID	2.1	1.6	2.8	3.8	4.7	1.9	7	7.9	3.5	2.2
CCD	1.3	1.4	2.5	3.2	4.4	1.6	6.3	7.0	3.1	2.1

Notes: Own illustration using data from the Survey of Consumer Finances, 1988 to 2009. Each column represents the yearly estimated values of the row variables in the year indicated on the column headings, and the last two columns report the average and standard deviation of these yearly estimates. The Normalized Tax Change (NTC) estimates how much aggregate tax revenue changes in response to a change in aggregate market income. The MPC Adjusted NTC (ANTC) estimates the change in aggregate taxes *that would have otherwise been spent* as a proportion of the change in aggregate market income. The NTC Shifter ($NTCS_X$) estimates the extra proportion of a fluctuation in market income that would be absorbed by the tax system in the absence of tax provision X. The ANTC Shifter ($ANTCS_X$) estimates the extra amount of consumption, as a proportion of a fluctuation in market income, that the tax system would have absorbed in the absence of tax provision X. Total personal income is the aggregate gross income subject to the federal income tax, which was obtained from the Internal Revenue Service's Statistics of Income Tax Stats on Individual Tax Returns. The "Consumption Sensitivity in the Absence of the Tax System" is the estimated income-weighted marginal propensity to consume, which can also be interpreted as the baseline response of aggregate consumption to income fluctuations in the absence of a tax system. The "Consumption Sensitivity in the Presence of the Tax System" is the estimated income-weighted marginal propensity to consume less the ANTC, which can also be interpreted as the response of aggregate consumption to income fluctuations in the presence of the tax system. The "Change in the Consumption Sensitivity Induced By the Expenditure" estimates the extent that the tax expenditure decreased the ability of the tax system to reduce the sensitivity of consumption with respect to market income changes, which is converted to dollar values based on a 3% recession by multiplying the it by the change in total personal income resulting from the 3% recession.

D.2 Identification of HtM Households

To estimate the ANTC according to Equation (4.2), we must first identify whether each household is hand-to-mouth (HtM). Under the standard assumption that each HtM household has an MPC = 1 while all other households have zero MPC, the change in disposable income for these households is then interpreted as a change in consumption. The automatic stabilization literature attempts to tackle the problem of identifying HtM households in a number of ways. Zeldes (1989) and Auerbach and Feenberg (2000) use a wealth to income ratio cutoff to define HtM households. Runkle (1991) classifies those households that do not own their own home as HtM. Jappelli et al. (1998) and Dolls et al. (2012) define a household as HtM if (1) a credit application has been either rejected or not fully approved, or (2) a credit application has not been submitted because of the fear of rejection. The main drawback of these approaches stems from the fact that they fail to capture the many wealthy households that have been widely identified in the literature as HtM (Campbell and Hercowitz, 2009; Broda and Parker, 2014; Hsieh, 2003; Agarwal et al., 2007; Misra and Surico, 2014; Telyukova, 2013; Browning and Collado, 2001; Browning and Crossley, 2001).

Kingi and Rozema (2015) point out that, within the context of estimating automatic stabilizers, the approach to identify HtM households in Kaplan and Violante (2014) (KV) overcomes this limitation. KV explain wealthy household HtM behavior by showing that many of these households choose to hold their wealth in the form of high return illiquid assets. These wealthy households choose to consume a large proportion of income fluctuations in order to avoid the costs associated with liquidating illiquid assets. KV define a household to be HtM if it either has zero liquid wealth or is at its credit limit. More formally, household i is HtM if either

$$0 \leq m_i \leq \frac{y_i}{2f_i}$$

or

$$m_i \leq 0 \text{ and } m_i \leq \frac{y_i}{2f_i} - \underline{m}_i$$

where m_i is the average balance of liquid assets over the past month, y_i is monthly labor income, $\underline{m}_i$ is the credit limit, and f_i is the pay period frequency. Liquid wealth includes cash, money market, checking, savings and call accounts. The SCF does not record household cash holdings, so KV identify revolving debt and impute cash holdings. For identifying revolving unsecured debt, KV follow the common strategy of excluding from debt the purchases made through credit cards between regular payments (Telyukova, 2013). In particular, they use direct evidence from the SCF that asks about credit card balances, including: (1) "How often do you pay your credit card balance in full?", where possible answers include: (a) Always or almost always; (b) Sometimes; or (c) Almost never, and (2) "After the last payment, roughly what was the balance still owed on these accounts?" KV identify households with revolving debt as those households that respond to the first question with (b) or (c), and for these households then compute statistics about credit card debt using the answer to the second question. To impute cash holdings, KV make use of previous estimates of median household cash holdings (Foster et al., 2011), and adjust for cash holdings by increasing the median wealth in checking, saving, money market, and call accounts as measured in the SCF by this amount.

The two separate HtM conditions in the KV approach capture how households with sufficiently low liquid assets with respect to their monthly income behave as

HtM. Both conditions are important in defining HtM households because households at kinks of their budget constraint have a high MPC out of a windfall gain in income, regardless of how they got there. The distinguishing factor between the KV approach and the Jappelli et al. (1998) approach is that the former can account not only for households living at their credit limit, but also for wealthy households who hold no liquid wealth. A more detailed discussion of this intuition and identification of these HtM households using the SCF can be found in Appendix B of KV. A complete discussion of how KV's HtM definition impacts the estimation of automatic stabilizers and, more generally, is important for the design of the microsimulation techniques used in the estimation of automatic stabilizers can be found in Kingi and Rozema (2015).

D.3 Accounting for Multiple Imputation

The SCF focuses on sensitive household information, and therefore nonresponse rates are nontrivial. Furthermore, the relatively common occurrence of unusual observations in the general population threaten the anonymity of many survey respondents. Since the comprehensive redesign of the survey in 1989, a multiple imputation procedure has been adopted to overcome these issues by replacing missing and sensitive values with five alternative values (Kennickell, 1998). These alternative values are drawn repeatedly from an estimate of the conditional distribution of the data, which is modeled using the Federal Reserve Imputation Technique Zeta model. The imputations are stored as five successive "implicates" of each household, so that the number of observations in the full data set (22,610 in 2004, for example) is five times the actual number of respondents.

The multiple imputation procedure has implications for the estimation of statistics. A point estimate, for example, is given by the mean of the estimates derived independently from each of the five separate implicates. The calculation of an appropriate estimate of variance is slightly more involved, because the multiple imputations add extra variability to the data. The best estimate of variance is the average of the variance estimates derived independently from each of the five implicates ("within" imputation variance), plus an estimate of the "between" imputation variance, with an adjustment factor for using a finite number of imputations. A detailed description of the procedure, along with computer code, is provided in the "Imputation" section of the 2004 SCF codebook.

We now describe how we estimate the results, adjusting for multiple imputation. Consider the right hand side panel of Figure D.2, which presents point estimates and standard deviation bands for the average total dollar amount of aggregate annual charitable giving from 1988 to 2009, broken down by income brackets. In order to calculate the point estimates, we first do so independently for each separate implicate. Let the point estimate and standard deviation for the average amount of aggregate annual charitable giving across the 1988 to 2009 period for implicate i be denoted by β_i and s_i respectively. The corresponding point estimates (β) presented in Figure D.2 are calculated by

$$\beta = \frac{\sum_{i=1}^{5} \beta_i}{5}$$

The standard deviations (σ) are calculated as follows

$$\sigma = \sqrt{(\bar{s} + 6/5 \cdot \hat{s})}$$

where $\bar{s}$ is the *within* imputation variation and $\hat{s}$ is the *between* imputation variance given by

$$\bar{s} = \frac{\sum_{i=1}^{5} s_i^2}{5} \quad , \quad \hat{s} = \frac{\sum_{i=1}^{5}(\beta - \beta_i)^2}{4}$$

An analogue procedure is used to calculate all the SCF-derived statistics presented in this article.

BIBLIOGRAPHY

Agarwal, S., C. Liu, and N. Souleles (2007). The Reaction of Consumer Spending and Debt to Tax Rebates–Evidence from Consumer Credit Data. *Journal of Political Economy 115*(6), 986–1019.

Altonji, J. and D. Card (1991). The Effects of Immigration on the Labor Market Outcomes of Less-skilled Natives. In *Immigration, Trade, and the Labor Market*, NBER Chapters, pp. 201–234. National Bureau of Economic Research, Inc.

Altshuler, R. and R. Dietz (2011). Reconsidering Tax Expenditure Estimation. *National Tax Journal 64*(2), 459–490.

Amromin, G., J. Huang, and C. Sialm (2007). The Tradeoff Between Mortgage Prepayments and Tax-Deferred Retirement Savings. *Journal of Public Economics 91*(10), 2014–2040.

Angrist, J. (1995). The Economic Returns to Schooling in the West Bank and Gaza Strip. *American Economic Review 85*(5), 1065–87.

Atkinson, A. (1970). On the Measurement of Inequality. *Journal of Economic Theory 2*(3), 244–263.

Auerbach, A. (2009). Implementing the New Fiscal Policy Activism. *American Economic Review 99*(2), 543–49.

Auerbach, A. and D. Feenberg (2000). The Significance of Federal Taxes as Automatic Stabilizers. *Journal of Economic Perspectives 14*(3), 37–56.

Aydemir, A. and G. Borjas (2007). Cross-Country Variation in the Impact of International Migration: Canada, Mexico and the United States. *Journal of the European Economic Association 5*(4), 663–708.

Bakija, J. and J. Slemrod (2004). Do the Rich Flee from High State Taxes? Evidence from Federal Estate Tax Returns. NBER Working Papers 10645, National Bureau of Economic Research, Inc.

Barro, R. and C. Sahasakul (1983). Measuring the Average Marginal Tax Rate from the Individual Income Tax. *Journal of Business 56*(4), 419–52.

Battisti, M., G. Felbermayr, G. Peri, and P. Poutvaara (2014). Immigration, Search, and Redistribution: A Quantitative Assessment of Native Welfare. Working Paper 20131, National Bureau of Economic Research.

Ben-Gad, M. (2004). The Economic Effects of Immigration - A Dynamic Analysis. *Journal of Economic Dynamics and Control 28*(9), 1825–1845.

Ben-Gad, M. (2008). Capital-Skill Complementarity and the Immigration Surplus. *Review of Economic Dynamics 11*, 335–365.

Berkovec, J. and D. Fullerton (1992). A General Equilibrium Model of Housing, Taxes, and Portfolio Choice. *Journal of Political Economy 100*(2), 390–429.

Berndt, E. and L. Christensen (1974). Testing for the Existence of a Consistent Aggregate Index of Labor Inputs. *American Economic Review 64*(3), 391–404.

Bianchi, M., B. Gudmundsson, and G. Zoega (2001). Iceland's Natural Experiment in Supply-Side Economics. *American Economic Review 91*(5), 1564–1579.

Binyamini, A. and A. Razin (2008). Inflation-Output Tradeoff as Equilibrium Outcome of Globalization. NBER Working Papers 14379, National Bureau of Economic Research, Inc.

Blinder, A. (1975). Distribution Effects and the Aggregate Consumption Function. *Journal of Political Economy 83*(3), 447–475.

Borjas, G. (1995). The Economic Benefits from Immigration. *Journal of Economic Perspectives 9*(2), 3–22.

Borjas, G. (1999). The Economic Analysis of Immigration. In O. Ashenfelter and D. Card (Eds.), *Handbook of Labor Economics*, Volume 3 of *Handbook of Labor Economics*, Chapter 28, pp. 1697–1760. Elsevier.

Borjas, G. (2003). The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market. *The Quarterly Journal of Economics 118*(4), 1335–1374.

Borjas, G. (2014). *Immigration Economics* (1 ed.). Harvard University Press.

Borjas, G., J. Grogger, and G. Hanson (2008). Imperfect Substitution between Immigrants and Natives: A Reappraisal. Working Paper 13887, National Bureau of Economic Research.

Borjas, G., J. Grogger, and G. Hanson (2012). On Estimating Elasticities of Substitution. *Journal of the European Economic Association 10*(1), 198–210.

Broda, C. and J. Parker (2014). The Economic Stimulus Payments of 2008 and the Aggregate Demand for Consumption. *Journal of Monetary Economics 68*, S20–S36.

Brown, E. (1955). The Static Theory of Automatic Fiscal Stabilization. *Journal of Political Economy 63*(5), 427–440.

Brown, E. and R. Kruizenga (1959). Income Sensitivity of a Simple Personal Income Tax. *Review of Economics and Statistics 41*(1), 260–69.

Browning, M. and D. Collado (2001). The Response of Expenditures to Anticipated Income Changes: Panel Data Estimates. *American Economic Review 91*(3), 681–692.

Browning, M. and T. Crossley (2001). Unemployment Insurance Benefit Levels and Consumption Changes. *Journal of Public Economics 80*(1), 1–23.

Burman, L. (2003). Is the Tax Expenditure Concept Still Relevant? *National Tax Journal 56*(3), 613–627.

Burman, L., C. Geissler, and E. Toder (2008). How Big Are Total Individual Income Tax Expenditures, and Who Benefits from Them? *American Economic Review, Papers and Proceedings 98*(2), 79–83.

Campbell, J. and Z. Hercowitz (2009). Liquidity Constraints of the Middle Class. Working Paper Series WP-09-20, Federal Reserve Bank of Chicago.

Card, D. (1990). The Impact of the Mariel Boatlift on the Miami Labor Market. *Industrial and Labor Relations Review 43*(2), 245–257.

Card, D. (2009). Immigration and Inequality. *American Economic Review 99*(2), 1–21.

Card, D. and T. Lemieux (2001). Can Falling Supply Explain the Rising Return to College for Younger Men? A Cohort-Based Analysis. *The Quarterly Journal of Economics 116*(2), 705–746.

Chassamboulli, A. and T. Palivos (2013). The Impact of Immigration on the Employment and Wages of Native Workers. *Journal of Macroeconomics 38, Part A*, 19–34.

Chassamboulli, A. and T. Palivos (2014). A Search-Equilibrium Approach to the Effects of Immigration on Labor Market Outcomes. *International Economic Review 55*(1), 111–129.

Chetty, R., A. Guren, D. Manoli, and A. Weber (2011). Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins. *American Economic Review 101*(3), 471–75.

Christiano, L. (1984). A Reexamination of the Theory of Automatic Stabilizers. *Carnegie-Rochester Conference Series on Public Policy 20*(1), 147–206.

Clemens, M. (2011). Economics and Emigration: Trillion-Dollar Bills on the Sidewalk? *Journal of Economic Perspectives 25*(3), 83–106.

Clemens, M., C. Montenegro, and L. Pritchett (2008). The Place Premium: Wage Differences for Identical Workers across the US Border. Policy Research Working Paper Series 4671, The World Bank.

Cobb-Clark, D. and V. Hildebrand (2006). The Wealth and Asset Holdings Of U.S.-Born and Foreign-Born Households: Evidence from Sipp Data. *Review of Income and Wealth 52*(1), 17–42.

Cohen, L. (1959). An Empirical Measurement of the Built-in Flexibility of the Individual Income Tax. *American Economic Review, Papers and Proceedings 49*(2), 532–541.

Dasgupta, P., A. Sen, and D. Starrett (1973). Notes on the Measurement of Inequality. *Journal of Economic Theory 6*(2), 180–187.

Denny, M. and M. Fuss (1977). The Use of Approximation Analysis to Test for

Separability and the Existence of Consistent Aggregates. *American Economic Review 67*(3), 404–18.

Diamond, P. (1982). Wage Determination and Efficiency in Search Equilibrium. *The Review of Economic Studies 49*(2), 217–227.

Dolls, M., C. Fuest, and A. Peichl (2012). Automatic Stabilizers and Economic Crisis: US vs. Europe. *Journal of Public Economics 96*(3-4), 279–294.

Dunsky, R. and J. Follain (2000). Tax-Induced Portfolio Reshuffling: The Case of the Mortgage Interest Deduction. *Real Estate Economics 28*(4), 683–718.

Dustmann, C., T. Frattini, and I. Preston (2013). The Effect of Immigration along the Distribution of Wages. *The Review of Economic Studies 80*(1), 145–173.

Dutta, B. (2002). Inequality, Poverty and Welfare. In K. Arrow, A. Sen, and K. Suzumura (Eds.), *Handbook of Social Choice and Welfare* (1 ed.), Volume 1, Chapter 12, pp. 597–633. Elsevier.

Fatas, A. and I. Mihov (2001). Government Size and Automatic Stabilizers: International and Intranational Evidence. *Journal of International Economics 55*(1), 3–28.

Fatas, A. and I. Mihov (2012). Fiscal Policy as a Stabilization Tool. *B.E. Journal of Macroeconomics 12*(3), 1–68.

Federal Reserve Bank (2015). The Recession and Recovery in Perspective. *Last Accessed September 17, 2015*.

Fields, G. (1989). On-the-Job Search in a Labor Market Model: Ex ante Choices and Ex post Outcomes. *Journal of Development Economics 30*(1), 159–178.

Fields, G. (2005). A Welfare Economic Analysis of Labor Market Policies in the Harris-Todaro Model. *Journal of Development Economics 76*(1), 127–146.

Flood, S., M. King, S. Ruggles, and J. R. Warren (2015). Integrated Public Use Microdata Series, Current Population Survey: Version 4.0. [Machine-readable database].

Follain, J. and L. Melamed (1998). The False Messiah of Tax Policy: What Elimination of the Home Mortgage Interest Deduction Promises and a Careful Look at What It Delivers. *Journal of Housing Research 9*(2), 179–199.

Foster, K., E. Meijer, S. Schuh, and M. Zabek (2011). The 2009 Survey of Consumer Payment Choice. *Public Policy Discussion Paper, Federal Reserve Bank of Boston 11*(1).

Gale, W., J. Gruber, and S. Stephens-Davidowitz (2007). Encouraging Homeownership Through the Tax Code. *Tax Notes*, June 18, 2007, 1171–1189.

Gali, J. (1994). Government Size and Macroeconomic Stability. *European Economic Review 38*(1), 117–132.

Gervais, M. and M. Pandey (2008). Who Cares about Mortgage Interest Deductibility? *Canadian Public Policy 34*(1), 1–23.

Gorodnichenko, Y., E. Mendoza, and L. Tesar (2012). The Finnish Great Depression: From Russia with Love. *American Economic Review 102*(4), 1619–44.

Greenwood, J., Z. Hercowitz, and G. Huffman (1988). Investment, Capacity Utilization, and the Real Business Cycle. *American Economic Review 78*(3), 402–17.

Griliches, Z. (1969). Capital-Skill Complementarity. *The Review of Economics and Statistics 51*(4), 465–68.

Grossman, J. (1982). The Substitutability of Natives and Immigrants in Production. *The Review of Economics and Statistics 64*(4), 596–603.

Harris, J. and M. Todaro (1970). Migration, Unemployment & Development: A Two-Sector Analysis. *American Economic Review 60*(1), 126–42.

Hilber, C. and T. Turner (2014). The Mortgage Interest Deduction and its Impact on Homeownership Decisions. *Review of Economics and Statistics 96*(4), 618–637.

Holter, H., D. Krueger, and S. Stepanchuk (2014). How Does Tax Progressivity and Household Heterogeneity Affect Laffer Curves? NBER Working Papers 20688, National Bureau of Economic Research, Inc.

Hosios, A. (1990). On the Efficiency of Matching and Related Models of Search and Unemployment. *Review of Economic Studies 57*(2), 279–98.

Hsieh, C. (2003). Do Consumers React to Anticipated Income Changes? Evidence from the Alaska Permanent Fund. *American Economic Review 93*(1), 397–405.

Hunt, J. (1992). The Impact of the 1962 Repatriates from Algeria on the French Labor Market. *Industrial and Labor Relations Review 45*(3), 556–572.

International Monetary Fund (2009). Group of Twenty – Global Economic Policies and Prospects. *Note by the Staff of the International Monetary Fund*.

International Organization for Migration (2013). World Migration Report 2013 - Migrant Well-Being and Development. Technical report, International Organization for Migration.

Iregui, A. (2005). Efficiency Gains from the Elimination of Global Restrictions on Labor Mobility. In G. Borjas and J. Crisp (Eds.), *Poverty, International Migration and Asylum*, pp. 211–238. Palgrave MacMillan.

Ireland, P. (1994). Supply-side Economics and Endogenous Growth. *Journal of Monetary Economics 33*(3), 559 – 571.

Jappelli, T., J. Pischke, and N. Souleles (1998). Testing For Liquidity Constraints In Euler Equations With Complementary Data Sources. *Review of Economics and Statistics 80*(2), 251–262.

Johnson, D., J. Parker, and N. Souleles (2006). Household Expenditure and the Income Tax Rebates of 2001. *American Economic Review 96*(5), 1589–1610.

Johnson, G. (1997). Changes in Earnings Inequality: The Role of Demand Shifts. *Journal of Economic Perspectives 11*(2), 41–54.

Jones, L. (1995). Net Wealth, Marginal Tax Rates, and the Demand for Home Mortgage Debt. *Regional Science and Urban Economics 25*(3), 297–322.

Kaplan, G. and G. Violante (2014). A Model of the Consumption Response to Fiscal Stimulus Payments. *Econometrica 82*(4), 1199–1239.

Katz, L. and K. Murphy (1992). Changes in Relative Wages, 1963-1987: Supply and Demand Factors. *The Quarterly Journal of Economics 107*(1), 35–78.

Kennickell, A. (1998). Multiple imputation in the survey of consumer finances. In *Proceedings of the Section on Business and Economic Statistics, 1998 Annual Meetings of the American Statistical Association*, pp. 63–74.

Kimball, M. and M. Shapiro (2008). Labor Supply: Are the Income and Substitution Effects Both Large or Both Small? NBER Working Papers 14208, National Bureau of Economic Research, Inc.

Kingi, H. and K. Rozema (2015). On the Measurement of Federal Taxes as

Automatic Stabilizers. Working Paper, available at `www.kylerozema.com/research`.

Kirchgassner, G. and W. Pommerehne (1996). Tax Harmonization and Tax Competition in the European Union: Lessons from Switzerland. *Journal of Public Economics 60*(3), 351–371.

Klein, P. and G. Ventura (2007). TFP Differences and the Aggregate Effects of Labor Mobility in the Long Run. *The B.E. Journal of Macroeconomics 7*(1), 1–38.

Kleven, H., C. Landais, and E. Saez (2013). Taxation and International Migration of Superstars: Evidence from the European Football Market. *American Economic Review 103*(5), 1892–1924.

Kleven, H., C. Landais, E. Saez, and E. Schultz (2014). Migration and Wage Effects of Taxing Top Earners: Evidence from the Foreigners' Tax Scheme in Denmark. *The Quarterly Journal of Economics*.

Kniesner, T. and J. Ziliak (2002). Tax Reform and Automatic Stabilization. *American Economic Review 92*(3), 590–612.

Krusell, P., T. Mukoyama, and A. Sahin (2010). Labour-Market Matching with Precautionary Savings and Aggregate Fluctuations. *The Review of Economic Studies 77*(4), 1477–1507.

Krusell, P., L. Ohanian, J.-V. Rios-Rull, and G. Violante (2000). Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis. *Econometrica 68*(5), 1029–1054.

Leeper, E. and S.-C. Yang (2008). Dynamic Scoring: Alternative Financing Schemes. *Journal of Public Economics 92*(1–2), 159 – 182.

Lehmann, E., L. Simula, and A. Trannoy (2014). Tax Me if You Can! Optimal Nonlinear Income Tax Between Competing Governments. *The Quarterly Journal of Economics*.

Leite-Monteiro, M. (1997). Redistributive Policy with Labour Mobility across Countries. *Journal of Public Economics 65*(2), 229–244.

Listokin, Y. (2012). Equity, Efficiency, and Stability: The Importance of Macroeconomics for Evaluating Income Tax Policy. *Yale Journal of Regulation 29*(1), 45–89.

Liu, X. (2010). On the Macroeconomic and Welfare Effects of Illegal Immigration. *Journal of Economic Dynamics and Control 34*(12), 2547–2567.

Ljungqvist, L. and T. Sargent (2011). A Labor Supply Elasticity Accord? *American Economic Review 101*(3), 487–91.

Longhi, S., P. Nijkamp, and J. Poot (2005). A Meta-Analytic Assessment of the Effect of Immigration on Wages. *Journal of Economic Surveys 19*(3), 451–477.

Longhi, S., P. Nijkamp, and J. Poot (2006). The Impact of Immigration on the Employment of Natives in Regional Labour Markets: A Meta-Analysis. IZA Discussion Papers 2044, Institute for the Study of Labor (IZA).

Lucas, R. (2003). Macroeconomic Priorities. *American Economic Review 93*(1), 1–14.

Mankiw, N. and M. Weinzierl (2006). Dynamic scoring: A back-of-the-envelope guide. *Journal of Public Economics 90*(8-9), 1415–1433.

Mayda, A. (2006). Who Is Against Immigration? A Cross-Country Investigation of Individual Attitudes toward Immigrants. *The Review of Economics and Statistics 88*(3), 510–530.

Mendoza, E., A. Razin, and L. Tesar (1994). Effective Tax Rates in Macroeconomics: Cross-country Estimates of Tax Rates on Factor Incomes and Consumption. *Journal of Monetary Economics 34*(3), 297–323.

Mendoza, E. and L. Tesar (1998). The International Ramifications of Tax Reforms: Supply-Side Economics in a Global Economy. *American Economic Review 88*(1), 226–45.

Mendoza, E., L. Tesar, and J. Zhang (2014). Saving Europe?: The Unpleasant Arithmetic of Fiscal Austerity in Integrated Economies. NBER Working Papers 20200, National Bureau of Economic Research, Inc.

Mertens, K. and M. Ravn (2013). The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States. *American Economic Review 103*(4), 1212–47.

Mirrlees, J. (1971). An Exploration in the Theory of Optimum Income Taxation. *Review of Economic Studies 38*(2), 175–208.

Mirrlees, J. (1982). Migration and Optimal Income Taxes. *Journal of Public Economics 18*(3), 319 – 341.

Misra, K. and P. Surico (2014). Consumption, Income Changes, and Heterogeneity: Evidence from Two Fiscal Stimulus Programs. *American Economic Journal: Macroeconomics 6*(4), 84–106.

Mortensen, D. and C. Pissarides (1994). Job Creation and Job Destruction in the Theory of Unemployment. *Review of Economic Studies 61*(3), 397–415.

Moy, H. M. and C. Yip (2006). The Simple Analytics of Optimal Growth with Illegal Migrants: A Clarification. *Journal of Economic Dynamics and Control 30*(12), 2469–2475.

Musgrave, R. and M. Miller (1948). Built-in Flexibility. *American Economic Review 38*(1), 122–128.

OECD (2011). Taxation and Employment.

Ottaviano, G. and G. Peri (2012). Rethinking the Effect of Immigration on Wages. *Journal of the European Economic Association 10*(1), 152–197.

Palivos, T. (2009). Welfare Effects of Illegal Immigration. *Journal of Population Economics 22*(1), 131–144.

Pechman, J. (1973). Responsiveness of Federal Income Tax to Changes in Income. *Brookings Papers on Economic Activity 4*, 385–421.

Pischke, J.-S. and J. Velling (1997). Employment Effects Of Immigration To Germany: An Analysis Based On Local Labor Markets. *The Review of Economics and Statistics 79*(4), 594–604.

Pissarides, C. and B. Petrongolo (2001). Looking into the Black Box: A Survey of the Matching Function. *Journal of Economic Literature 39*(2), 390–431.

Pistaferri, L. (2003). Anticipated and Unanticipated Wage Changes, Wage Risk, and Intertemporal Labor Supply. *Journal of Labor Economics 21*(3), 729–754.

Poterba, J. (1984). Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach. *Quarterly Journal of Economics 99*(4), 729–52.

Poterba, J. (2011). Introduction: Economic Analysis of Tax Expenditures. *National Tax Journal 64*(2), 451–57.

Poterba, J. and T. Sinai (2008). Tax Expenditures for Owner-Occupied Housing: Deductions for Property Taxes and Mortgage Interest and the Exclusion of Imputed Rental Income. *American Economic Review 98*(2), 84–89.

Poterba, J. and T. Sinai (2011). Revenue Costs and Incentive Effects of the Mortgage Interest Deduction for Owner-Occupied Housing. *National Tax Journal 64*(2), 531–564.

Prescott, E. (2004). Why do Americans Work so Much More than Europeans? *Quarterly Review*, 2–13.

Rasmussen, E. (2013). How Immigration Can Hurt a Country. Working paper, Indiana University.

Razin, A. and E. Sadka (2011). Tax Competition and Migration: The Race-to-the-Bottom Hypothesis Revisited. NBER Working Papers 16670, National Bureau of Economic Research, Inc.

Runkle, D. (1991). Liquidity Constraints and the Permanent-Income Hypothesis: Evidence from Panel Data. *Journal of Monetary Economics 27*(1), 73–98.

Saez, E. (2004). Reported Incomes and Marginal Tax Rates, 1960-2000: Evidence and Policy Implications. In J. Poterba (Ed.), *Tax Policy and the Economy*, Volume 18, pp. 117–174. MIT Press.

Schmitt-Grohe, S. and M. Uribe (1997). Balanced-Budget Rules, Distortionary Taxes, and Aggregate Instability. *Journal of Political Economy 105*(5), 976–1000.

Shaw, R. P. (1986). Fiscal versus Traditional Market Variables in Canadian Migration. *Journal of Political Economy 94*(3), 648–66.

Shimer, R. (2012). Reassessing the Ins and Outs of Unemployment. *Review of Economic Dynamics 15*(2), 127–148.

Simula, L. and A. Trannoy (2010). Optimal Income Tax Under the Threat of Migration by Top-income Earners. *Journal of Public Economics 94*(1–2), 163 – 173.

Slitor, R. (1948). The Measurement of Progressivity and Built-In Flexibility. *Quarterly Journal of Economics 62*(2), 309–313.

Telyukova, I. (2013). Household Need for Liquidity and the Credit Card Debt Puzzle. *Review of Economic Studies 80*(3), 1148–1177.

Temple, J. (2005). Growth and Wage Inequality in a Dual Economy. *Bulletin of Economic Research 57*(2), 145–169.

Tiebout, C. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy 64*, 416.

Trabandt, M. and H. Uhlig (2011). The Laffer Curve Revisited. *Journal of Monetary Economics 58*(4), 305–327.

Transatlantic Trends (2013). Transatlantic Trends: Mobility, Migration and Integration. Technical report, The German Marshall Fund of the United States.

van den Noord, P. (2000). The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond. *OECD Economics Department Working Papers* (230).

World Bank (2012). *World Development Report 2013: Jobs*. Washington, DC: World Bank,.

Young, C. and C. Varner (2011). Millionaire Migration and State Taxation of Top Incomes: Evidence from a Natural Experiment. *National Tax Journal 64*(2), 255–83.

Zeldes, S. (1989). Consumption and Liquidity Constraints: An Empirical Investigation. *Journal of Political Economy 97*(2), 305–346.